No. 00007

141848

FINAL DRAFT w/ additions 7/19/89
FEASIBILITY STUDY REPORT
FOR OPERABLE UNIT ONE
AUTO ION SITE
KALAMAZOO, MICHIGAN

JUNE 1989

Prepared for:

Auto Ion Steering Committee

Prepared by:

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Pennsauken, New Jersey

(CL5203B/1)

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EXECUTIVE SUMMARY

This report constitutes the Final Draft Feasibility Study Report for the Auto-Ion Site in Kalamazoo, Michigan. It addresses the process behind the development, screening and detailed analysis of remedial action Alternatives for mitigating potential risks to human health and the environment posed by soil contamination at the Site. The Feasibility Study was conducted in accordance with US EPA guidance (OSWER Directive 9355.3-010, as well as the Administrative Order by Consent executed by the US EPA and the Auto-Ion Steering Committee.

During the technology screening and Alternative development phases of the FS, a total of 13 Alternatives were formulated. These Alternatives were screened in terms of effectiveness, implementability and cost to yield a list of six (6) Alternatives for detailed analysis. The surviving Alternatives were evaluated in detail in terms of the following criteria:

- Reduction of mobility, toxicity and volume;
- Short-term Effectiveness;
- Long-term Effectiveness and Permanence;
- Implementability;
- Overall protection of human health and the environment;
- Compliance with applicable or relevant and appropriate requirements;
- Cost.

After detailed evaluation, the Alternatives were compared in tabular form.

The Alternatives that survived the screening process and that were retained for detailed analysis were:

- Alternative 1 - No Action.

- Alternative 3 - Partial Excavation, Stabilization, On-Site Backfilling and Construction of a Multi-Layer Capping System.

- Alternative 4 - Vadose Zone Excavation, Off-Site Land Disposal and Site Restoration By Backfilling and Revegetating.

- Alternative 5 - Limited Vadose Zone Excavation, Off-Site Land Disposal and Site Restoration By Backfilling and Regrading.

- Alternative 7 - Vadose Zone Excavation, On-Site Stabilization, Off-Site Land Disposal of the Stabilized Wastes, and Site Restoration by Backfilling and Regrading.

- Alternative 8 - Limited Vadose Zone Excavation, On-Site Stabilization, Off-Site Land Disposal of the Stabilized Wastes, and Site Restoration by Backfilling and Regrading.

Numerous differences among the Alternatives are evident as djscussed in Section 5. Capital costs for the Alternatives ranged up to $9.5 million, whereas total present worth ranged from about $544,000 to $9.6 million.

1.0 INTRODUCTION

1.1 Purpose

This Draft Feasibility Study Report has been prepared as required by Attachment 1, Tasks 6 through 11 of the Administrative Order by Consent executed by the United States Environmental Protection Agency (US EPA) and members of the Auto Ion Steering Committee[1]. It addresses the process behind the development, screening and detailed analysis of remedial action alternatives for the Auto Ion Site in Kalamazoo, Michigan. The report includes a summary of existing background information of the site followed by the identification and screening of remedial action technologies. Screening of these technologies for site applicability will then be performed in support of the development of the remedial action alternatives. The remedial alternatives will then be screened in order to develop a list of alternatives for detailed evaluation. An independent, detailed evaluation will then be performed for each alternative using technical, environmental, public health and economic criteria. The results of the independent alternative evaluations will then be compared and summarized.

As requested by EPA Region V, remedial actions for the Site will be developed, evaluated, selected and implemented as a sequence of "Operable Units." The concept of Operable Units is described in the National Contingency Plan (NCP, 40 CFR 300), and it is the EPA's desire to utilize this concept in order to address relatively straightforward problem areas at complex sites. This Feasibility Study represents the development and evaluation of alternatives for remediating soil contamination at the Auto Ion Site. Soil remediation is hereafter referred to as Operable Unit One.

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[1]US EPA Docket No. V-W-86-C-07, effective date August 27, 1986.

1.2 Background

1.2.1 Site Description

The Auto Ion property, hereafter referred to as the "Site", is located at 74 Mills Street in a commercial/industrial district of northeast Kalamazoo, Michigan (see Figure 1-1). The Site occupies approximately 1.5 acres of vacant fenced land, adjacent to the Kalamazoo River. The Site is bordered to the north by O'Neil Street and to the east by Mills Street. A painting facility is in operation to the west of the Site.

As of the 1980 census, the population of Kalamazoo was 77,226. The population with a 1 mile radius was about 36,000. The nearest residence is situated about 500 feet north of the Site on Mills Street (adjacent to the main railroad line).

There are two nearby hospitals. One is located approximately one mile northeast of the Site and the other is located approximately one mile southwest of the Site. A school is located approximately one-half mile north of the Site. Sutherland Park is also located south of the Site and across the river, upstream from the golf course. Playgrounds are located approximately one mile northeast and one mile northwest of the Site.

Only recreational fishing is allowed in the Kalamazoo River. However, consumption of carp, suckers, catfish and large mouth bass is prohibited since the River is classified as a 307 (Michigan Public Act 307) site. Consumption of all other fish, while not prohibited, is restricted from one mile upstream of the Site to Lake Michigan, a distance of 80 miles. Restrictions, based on levels of PCB contamination in fish, surface water and sediments, include no ingestion by pregnant women and less than one meal per week by women of child-bearing age who intend to have children and children under fifteen years of age (Fisheries Department, MDNR).

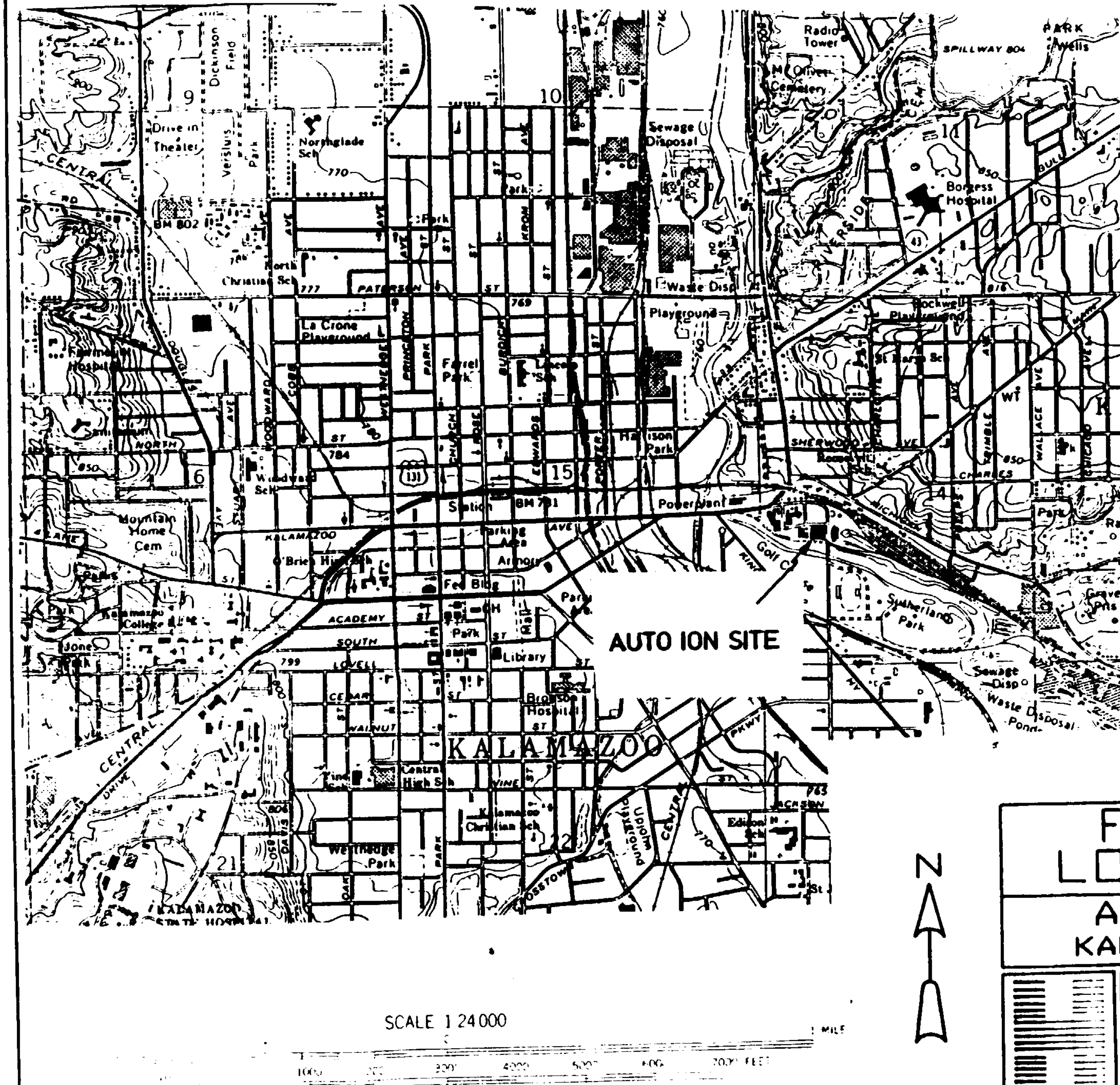

FIGURE 1-1 LOCATION MAP

AUTO ION SITE
KALAMAZOO, MICHIGAN

DATE: 10/21/88

SCALE: AS SHOWN

FRED C. HART ASSOCIATES, INC.

Site relief is very nearly flat and all of the former buildings have been removed. A cement slab in the northeast portion of the Site which covers approximately 465 square yards is the only notable remaining feature (see Figure 1-2).

Two to twelve feet of medium grained sand, mixed with gravel, brick and cinder fragments make up the fill material which covers the Site. Underlying the fill is approximately 100 feet of glacial material consisting of medium sand with interbedded gravel, silt and clay. Clay lenses are common. Glacial deposits overlie Mississippian age bedrock of the Coldwater Shale. Geologic cross sections for the site are shown in Figures 1-3 through 1-5. The glacial material beneath the Site creates mostly unconfined aquifer conditions with clay layers creating localized confined aquifer regions of limited extent. Average depth to groundwater at the Site is about 10 feet. Under normal conditions groundwater flow is towards the river in a southerly direction; however, due to the high permeability of the soil and Site conditions, the groundwater flow direction is highly variable and is thought to be related to water level fluctuations in the adjacent River. Water level data indicate that recent precipitation events dictate the direction of flow in the aquifer beneath the Auto Ion Site. Due to the variability of groundwater flow direction at the Auto Ion Site a consistent upgradient or downgradient well pattern cannot be established hence a consistent contaminant transport direction is not established. Additional information regarding Site geology and hydrogeology is contained in Chapter 4 of the Remedial Investigation Report.

Surface water from the Site drains to the Kalamazoo River via direct runoff or through a stormwater drain along the eastern edge of the property. Site topography is shown in Figure 1-6.

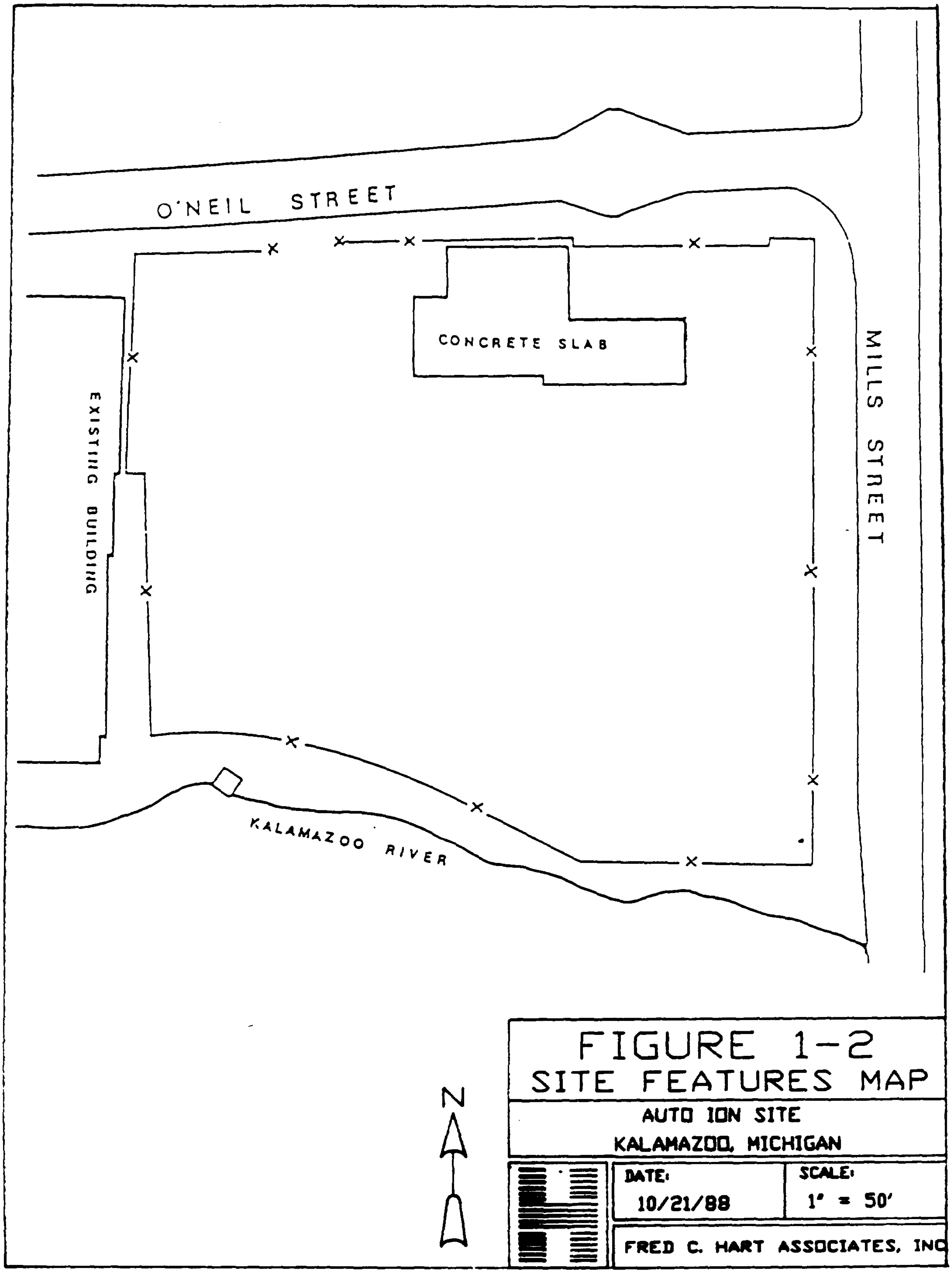

FIGURE 1-2
SITE FEATURES MAP

AUTO ION SITE
KALAMAZOO, MICHIGAN

DATE: 10/21/88

SCALE: 1" = 50'

FRED C. HART ASSOCIATES, INC

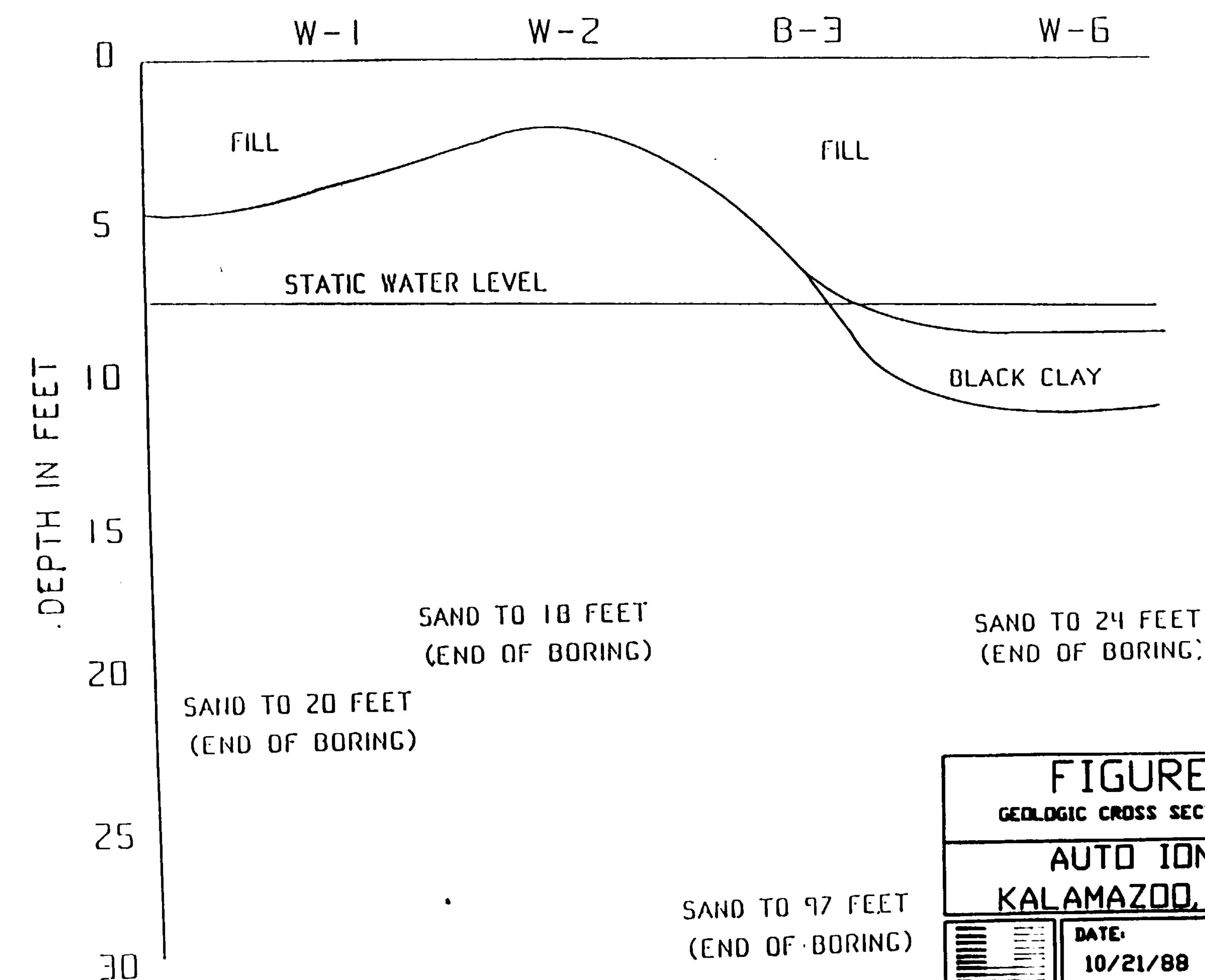

FIGURE 1-3

GEOLOGIC CROSS SECTION W-1 TO W-6

AUTO ION SITE
KALAMAZOO, MICHIGAN

DATE: 10/21/88

SCALE: none

FRED C. HART ASSOCIATES, INC.

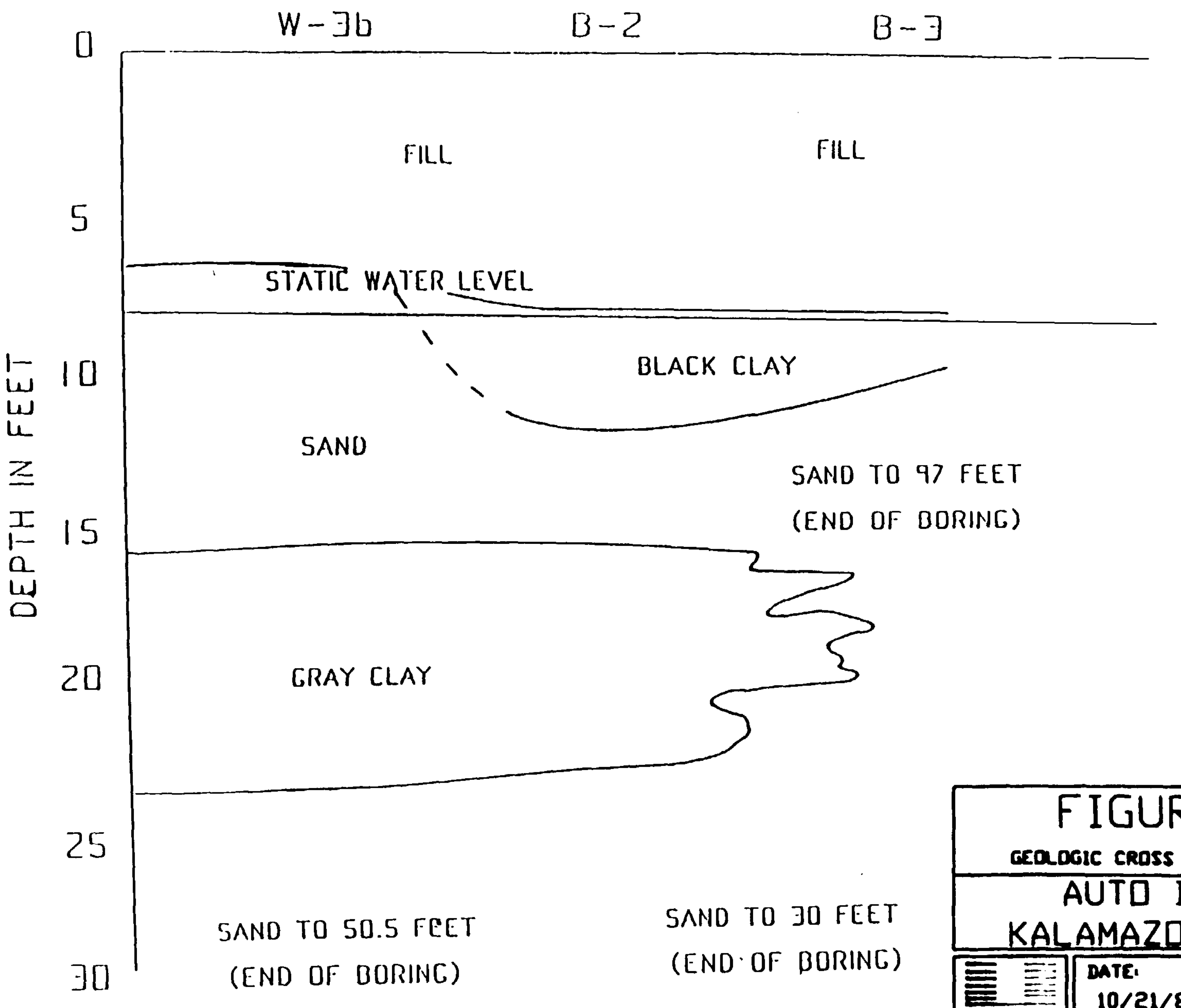

FIGURE 1-4

GEOLOGIC CROSS SECTION W-3b TO B-3

AUTO ION SITE
KALAMAZOO, MICHIGAN

DATE:	SCALE:
10/21/88	none

FRED C. HART ASSOCIATES, INC.

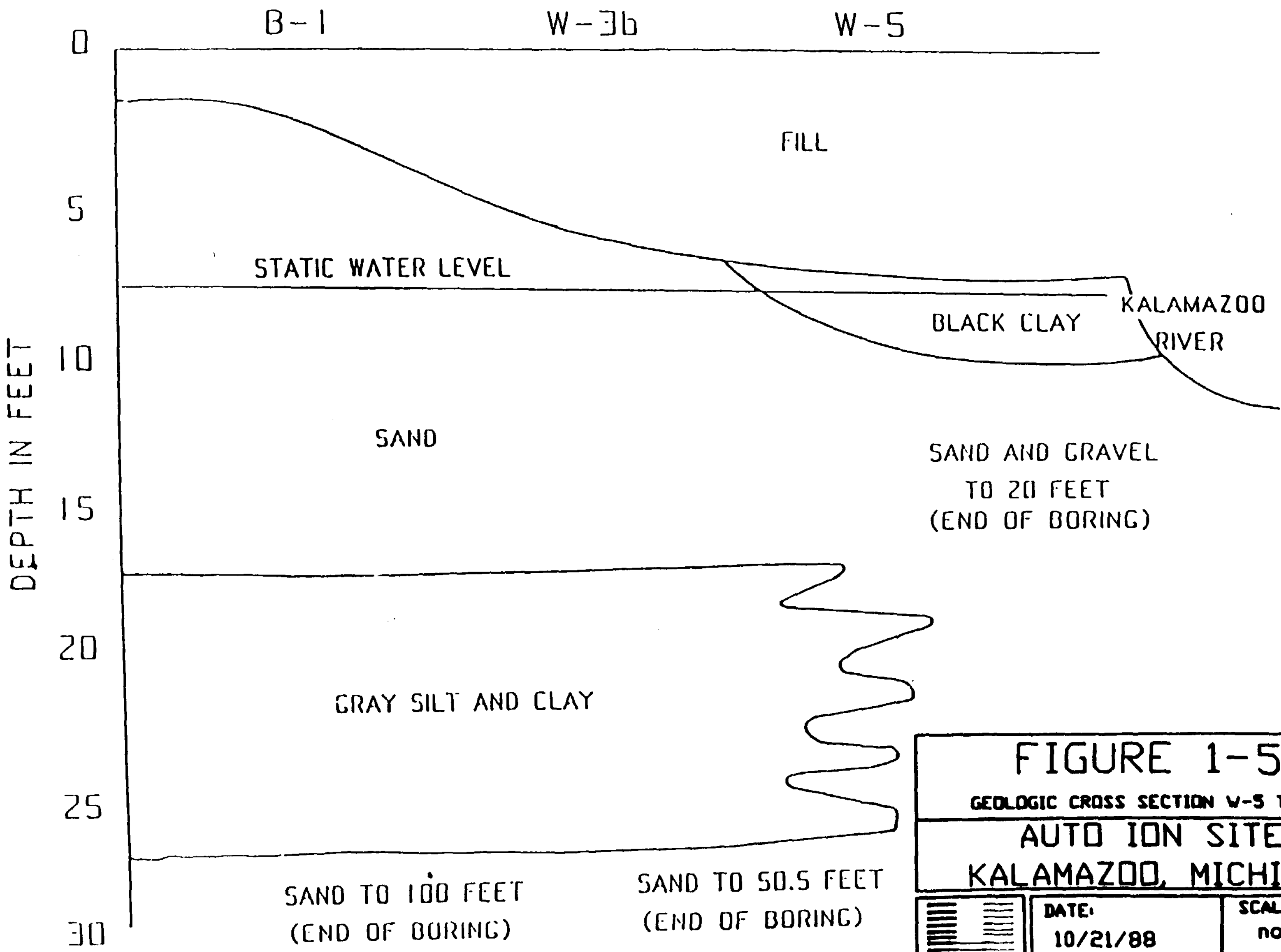

FIGURE 1-5

GEOLOGIC CROSS SECTION W-5 TO B-1

AUTO ION SITE
KALAMAZOO, MICHIGAN

DATE: 10/21/88

SCALE: none

FRED C. HART ASSOCIATES, INC.

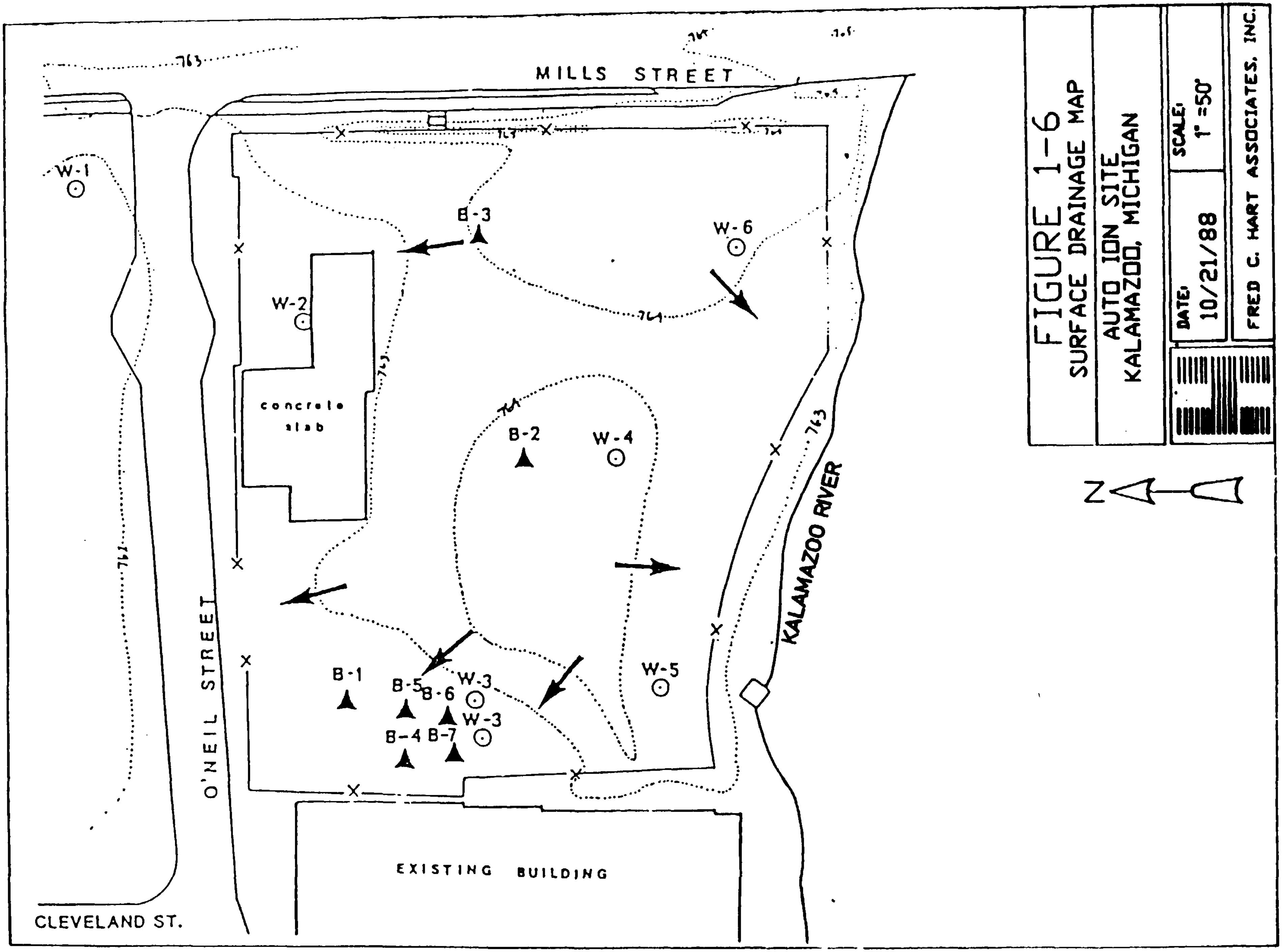

FIGURE 1-6
SURFACE DRAINAGE MAP
AUTO ION SITE
KALAMAZOO, MICHIGAN
SCALE:
1" =50'
DATE:
10/21/88
FRED C. HART ASSOCIATES, INC.
MILLS STREET
O'NEIL STREET
CLEVELAND ST.
KALAMAZOO RIVER
EXISTING BUILDING
concrete
slab
W-1
W-2
W-3
W-3
W-4
W-5
W-6
B-1
B-2
B-3
B-4
B-5
B-6
B-7
763
764
762
N

1.2.2 Site History

The property at 74 Mills Street was originally used as an electrical generating station by the city of Kalamazoo from sometime during the 1940's until 1956, when Consumers Power purchased the plant. Shortly thereafter the power plant was closed and dismantled. In 1963 the land was sold to Mr. James Rooney, owner of Auto Ion Chemical Company, which began operations in 1964. The facility received chrome and cyanide plating waste to precipitate the heavy metals and deposit it into a lagoon. After removal of the precipitate, the wastewater was discharged into the sanitary sewer. Cyanide was destroyed by chlorine treatment and other methods. During these operations, wastes were reportedly discharged to site soils, sewers and the Kalamazoo river. Additionally, poor storage practices were reportedly followed on site. A chronology of significant events related to the Site describing the discharges and storage practice problems is provided in Appendix II of the Remedial Investigation Report.

It was also reported that an organic fertilizer company operated in one of the buildings on Site during the late 1960's and organic fertilizer waste may have been left on Site. The Auto Ion facility ceased active waste handling operations in 1973 when its license to transport, store and treat liquid industrial waste was not renewed. Contained and uncontained waste was left in the building and on the grounds at this time.

In 1983, an Emergency Action Plan was prepared by EPA's Technical Assistance Team (TAT). In accordance with the Emergency Action Plan a surface removal was conducted by OH-Materials, Inc. on behalf of the Auto Ion Steering Committee. This was followed by the demolition of buildings, under the direction of the City of Kalamazoo in 1986.

1.2.3 Nature and Extent of Contamination

A Remedial Investigation (RI) including soil, groundwater, surface water and sediment sampling and analysis was conducted by HART from October 1987 through March 1988. The work plan setting forth the procedures for these activities was developed by Woodward-Clyde Consultants of Chicago, Illinois and was reviewed and approved by EPA Region V. The detailed findings and results of the investigation are contained in the Remedial Investigation Report, however, a brief summary of those findings and results is presented in this section. Table 1-1 summarizes the results of this sampling and analysis work.

1.2.3.1 Soils

During the RI, 14 test borings were drilled to examine subsurface geology and to facilitate the collection of soil samples for chemical and physical analyses. Seven of the soil borings were subsequently converted into monitoring wells (see Figure 1-7). Soil borings were performed using a hollow stem auger rig to the desired depth below the water table or until bedrock was encountered. Details regarding the drilling and sample collection procedures are provided in the RI report. Test boring logs prepared by HART are provided in Appendix A of this report. The locations of the soil borings are shown in Figure 1-7.

1.2.3.1.1 Geotechnical Findings

Grain size distributions were examined by performing sieve analyses on 15 discrete samples from 6 boring locations. Grain size distribution curves are provided in Appendix B of this report. In general, the grain size distributions showed well graded and gap graded sediments, and indicated that the sediments are of glacial or fluvial-glacial origin. Sediments ranged from sandy gravel (at B-1, W-2 and B-3) to samples with 90% passing a #200 sieve (at B-2 and W-5). Sieve analyses for Well W-38 showed uniform sands with a D_{10} of 0.1 mm and a uniformity coefficient ($C_u = D_{60}/D_{10}$) of 2.

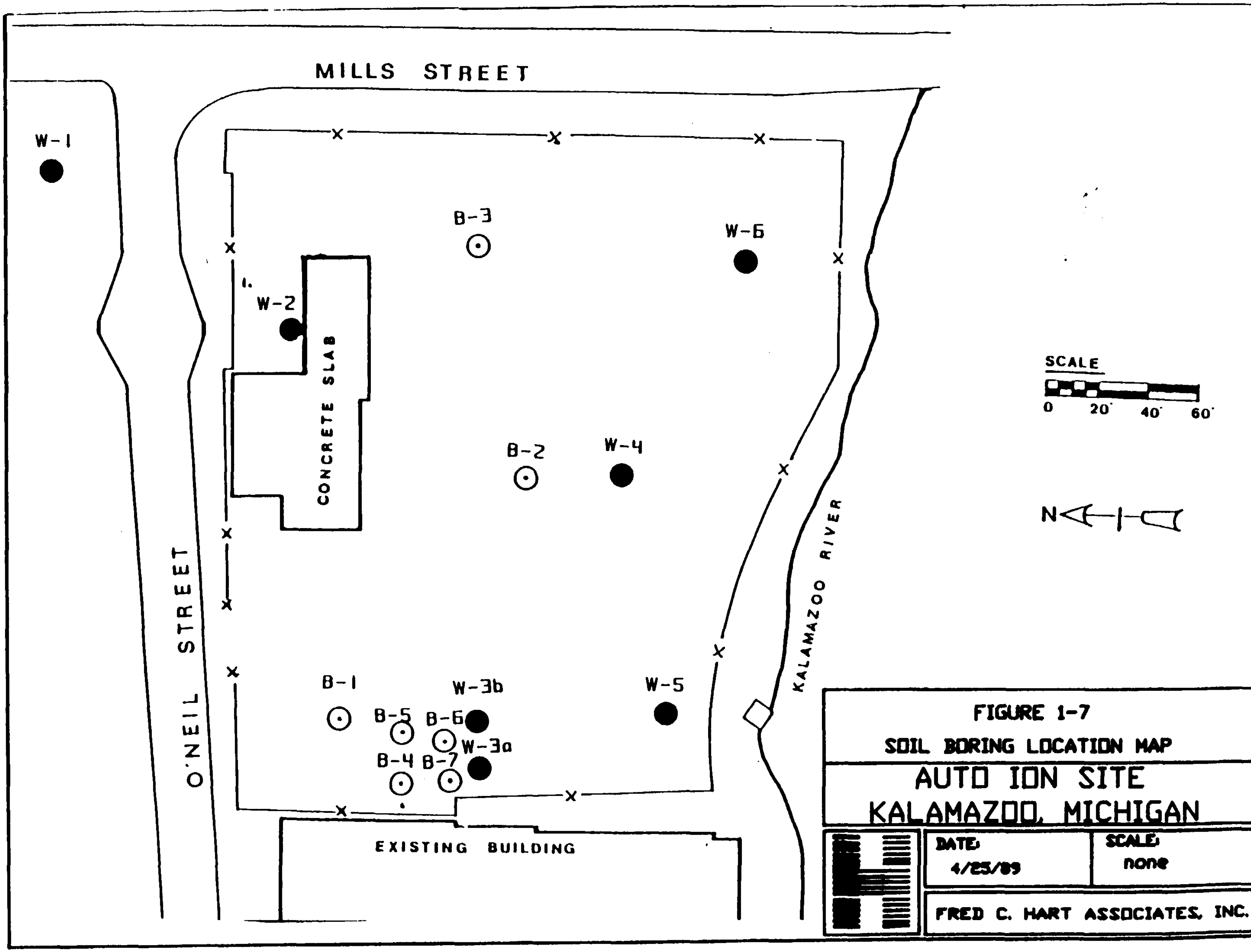
MILLS STREET
O'NEIL STREET
W-1
W-2
B-3
W-6
CONCRETE SLAB
B-2
W-4
SCALE
0
20'
40'
60'
N
KALAMAZOO RIVER
B-1
W-3b
W-5
B-5
B-6
W-3a
B-4
B-7
EXISTING BUILDING
FIGURE 1-7
SOIL BORING LOCATION MAP
AUTO ION SITE
KALAMAZOO, MICHIGAN
DATE:
4/25/89
SCALE:
none
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TABLE 1-1

SUMMARY OF EXISTING CONDITIONS
(NOVEMBER, 1987)

Sampling Location	Substances Detected(1)	Comments
SOILS		
- Former facility area	Organics: - Base Neutrals Metals Pesticides	Heptachlor found at 18.5' to 20' depth only
- Former aboveground storage tanks and seepage lagoon areas	Organics: - Base Neutral Metals Pesticide	Beta-BHC found below the clay layer at 29' to 50.5'
- North and northeast areas of the Site	Metals	Not analyzed for organics, PCBs or Pesticides
- Southern area of the Site	Metals	Not analyzed for PCBs or pesticides
SHALLOW GROUNDWATER[2]	Organics: - VOCs - phthalates Metals	
DEEP GROUNDWATER[2]	Organics: - phthalates Metals	

TABLE 1-1 (Continued)

SUMMARY OF EXISTING CONDITIONS
(NOVEMBER, 1987)

Sampling Location	Substances Detected[1]	Comments
SURFACE WATER[3]	Organics: - acetone - bis(2-Ethyl Hexyl) phthalate Metals	Not analyzed for PCBs Pesticides
RIVER SEDIMENTS	Organics: - VOCs - SVOCs Metals PCBs	PCBs occurring in downstream sediments

Notes:

(1) This column summarizes the results of the HART sampling and analyses work, as contained in the Auto Ion Remedial Investigation report, Draft, HART, July 4, 1988. Refer to list of abbreviations and acronyms following the table of contents for the RI report for definition of terms.

(2) Shallow groundwater is defined as the groundwater found in the wells screened in the water table Aquifer. Deep groundwater is groundwater below the confining gray clay layer.

(3) Surface water is the Kalamazoo River.

1.2.3.1.2 Inorganic Results

Soil samples collected from the borings were also analyzed for organic and inorganic chemical parameters. Complete data packages (including case narratives and QA/QC documentation) were presented in Appendix V of the RI report. Laboratory data sheets for these analyses are also presented in Appendix C of this report.

Inorganic elements detected in soils whose average concentrations exceeded average regional background levels include the following: arsenic, beryllium, cadmium, chromium, copper, cyanide, lead, magnesium, mercury, nickel, selenium, silver, thallium and zinc. A summary of the analytical results for the soil samples collected during the RI is presented in Tables 1-2 and 1-3. The individual analyses are summarized in Appendix C.

Contamination by inorganic elements and cyanide is the primary concern in the soils at the Site due to the fact that plating wastes were handled at the facility. The background boring (W-1) showed concentrations of inorganic elements that were within or below the average regional background levels cited in Tables 1-2 and 1-3. One exception to this was magnesium which was found in concentrations ranging from 5135 to 12,100 mg/kg.

Boring W-2 also showed magnesium (7,019-14,600 mg/kg) above the average regional background level, however, these concentrations were not significantly elevated with respect to the magnesium concentrations observed in the background boring (W-1). Cyanide (5.1 mg/kg) was detected in boring W-2 in the upper two feet below the surface. Chromium was also found above regional background levels at concentrations up to 177 mg/kg, however this seems to be confined to the upper 4 feet of soil. The remaining inorganics found in boring W-2 were within regional background levels.

TABLE 1-2

ANALYTICAL SUMMARY - SURFACE SOILS

Parameter	Number of Samples	Number Positive IDs	Sample Range Low	Sample Range High	Sample Mean	Background Surface Soil Sample	Average[5] Regional Background Levels
Metals:							
Aluminum	11	11	2668.00	4464.00	3473.55	5243	1,000-50,000
Antimony	4	0	BDL	BDL	BDL	R	<1-10
Arsenic	12	10	BDL	80.00*	21.03*	4.5	<1-6.5
Barium	11	8	BDL	280.00	132.00	40.0	300-500
Beryllium	12	1	BDL	1.30*	1.30*	U	<1
Cadmium	12	4	BDL	9.20*	4.40*	U	0.01-2.0[6]
Chromium	12	12	17.00	2433.00*	676.54*	11.0	1-30
Cobalt	12	1	BDL	5.00	5.00	U	<3-7
Copper	12	12	13.00	1203.00*	249.67*	12.0	<1-20
Cyanide	11	10	BDL	74.00	22.64*	R	
Iron	11	11	1000.00	45200.00*	15704.73	9694	1,000-20,000
Lead	12	12	5.60	928.00*	166.32*	23.0	<10-20
Magnesium	12	11	BDL	26300.00*	10889.00*	6135	100-3,000
Manganese	11	11	35.00	310.00	200.45	287	<2-2,000
Mercury	10	8	BDL	0.50*	0.25*	U	0.032- 0.130
Nickel	12	12	13.00	1020.00*	199.79*	7.9	<5-15
Selenium	12	1	BDL	2.00*	2.00*	U	<0.1-0.5
Silver	12	1	BDL	3.30*	3.30*	U	<0.1-1.0[6]
Thallium	12	1	BDL	5.10*	5.10*	U	<0.1-0.8[6]
Vanadium	12	10	BDL	17.00	12.99	12.0	<7-50
Zinc	12	12	29.00	1474.00*	236.83*	40.0	28-74
Organics:							
Anthracene	2	1	BDL	11.00	11.00	NA	-
Fluoranthene	2	2	0.41	11.00	5.70	NA	-
Pyrene	2	2	0.37	0.48	0.43	NA	-
Bis (2-ethylhexyl) phthalate	2	1	BDL	0.94	0.94	NA	-
Di-n-butylphthalate	2	2	0.52	3.60	2.06	NA	-

NOTES:

1. All data in mg/kg
2. BDL = Below detection limit
3. NA = Not Analyzed
4. * = value greater than regional background
5. Source: Shacklette and Berngen, 1984
6. Source: Adriano, 1986

(CL5105B/1633N)

TABLE 1-3

ANALYTICAL SUMMARY - SUBSURFACE SOILS

Parameter	Samples Collected From 2-20 ft.					Samples Collected From Depths Greater than 20 ft.				
	Number of Samples	Number Positive IDs	Sample Range Low	Sample Range High	Sample Mean	Number of Samples	Number Positive IDs	Sample Range Low	Sample Range High	Sample Mean
Inorganics:										
Aluminum	50	50	153.00	11700.00	3826.66	30	30	542.00	11700.00	1786.27
Antimony	24	1	BDL	6.50	6.50	22	1	BDL	22.00*	22.00*
Arsenic	47	34	BDL	56.00*	11.17*	30	6	BDL	20.00*	8.25*
Barium	49	21	BDL	640.00*	177.95	30	2	BDL	152.00	118.50
Beryllium	50	3	BDL	1.70*	1.40*	30	0	BDL	BDL	BDL
Cadmium	50	10	BDL	12.00*	2.70*	30	1	BDL	1.10	1.10
Chromium	50	50	7.50	3521.00*	548.82*	30	30	8.00	535.00*	41.84*
Cobalt	50	2	BDL	24.00*	19.50*	30	0	BDL	BDL	BDL
Copper	50	46	BDL	10100.00*	442.73*	30	8	BDL	119.00*	23.63*
Cyanide	35	22	BDL	531.00	48.98	22	4	BDL	4.40	2.30
Iron	49	49	2662.00	101200.00*	6335.80	30	30	1540.00	63700.00*	5646.27
Lead	50	49	BDL	603.50*	32.11*	30	10	BDL	27.00*	7.76
Magnesium	50	43	BDL	27000.00*	8889.09*	30	30	4260.00	26200.00*	8329.30*
Manganese	49	49	29.00	1838.00	238.80	30	30	41.00	1352.00	138.73
Mercury	41	15	BDL	4.60*	0.75*	29	5	BDL	2.00*	0.64*
Nickel	50	48	BDL	3291.00*	286.35*	30	8	BDL	89.00*	24.81*
Thallium	50	1	BDL	4.40*	4.40*	30	0	BDL	BDL	BDL
Selenium	49	1	BDL	1.30*	1.30*	30	0	BDL	BDL	BDL
Silver	50	3	BDL	4.40*	3.27*	30	1	BDL	8.50*	8.50*
Vanadium	50	27	BDL	32.00	15.90	30	5	BDL	30.00	15.02
Zinc	47	47	8.70	1409.50*	145.58*	30	27	BDL	145.00*	21.44

TABLE 1-3 (Continued)

ANALYTICAL SUMMARY - SUBSURFACE SOILS

Parameter	Samples Collected From 2-20 ft. Number of Samples	Number Positive IDs	Sample Range Low	High	Sample Mean	Samples Collected From Depths Greater than 20 ft. Number of Samples	Number Positive IDs	Sample Range Low	High	Sample Mean
Organics:										
Acetone	6	3	BDL	0.11	0.05	1	1	0.01	0.01	0.01
Carbon Disulfide	6	2	BDL	0.06	0.04	1	0	BDL	BDL	BDL
Ethylbenzene	6	2	BDL	4.20	2.10	1	0	BDL	BDL	BDL
Methylene Chloride	6	5	BDL	0.87	0.19	1	0	BDL	BDL	BDL
Tetrachloroethene	6	2	BDL	3.10	1.56	1	0	BDL	BDL	BDL
Trans-1,2-Dichloroethane	6	1	BDL	0.01	0.01	1	0	BDL	BDL	BDL
1,1,1-Trichloroethane	6	2	BDL	0.01	0.01	1	0	BDL	BDL	BDL
Trichloroethene	6	2	BDL	0.10	0.07	1	0	BDL	BDL	BDL
Toluene	6	5	BDL	8.00	1.62	1	0	BDL	BDL	BDL
Total Xylenes	6	1	BDL	31.00	31.00	1	0	BDL	BDL	BDL
Anthracene	5	1	BDL	0.37	0.37	4	0	BDL	BDL	BDL
Benzo(a)anthracene	6	3	BDL	1.70	0.91	4	0	BDL	BDL	BDL
Benzo(a)pyrene	6	2	BDL	0.44	0.42	4	0	BDL	BDL	BDL
Benzo(b)fluoranthene	6	2	BDL	2.50	1.69	4	0	BDL	BDL	BDL
2-Butanone	6	5	BDL	9.50	1.99	4	0	BDL	BDL	BDL
Chrysene	6	3	BDL	1.40	0.74	4	0	BDL	BDL	BDL
Fluoranthene	6	3	BDL	3.30	1.30	4	0	BDL	BDL	BDL

TABLE 1-3 (CONTINUED)

Parameter	Samples Collected From 2-20 ft. Number of Samples	Number Positive IDs	Sample Range Low	Sample Range High	Sample Mean	Samples Collected From Depths Greater than 20 ft. Number of Samples	Number Positive IDs	Sample Range Low	Sample Range High	Sample Mean
Phenanthrene	6	3	BDL	3.00	1.63	4	0	BDL	BDL	BDL
Pyrene	6	4	BDL	3.00	1.33	4	0	BDL	BDL	BDL
Styrene	6	1	BDL	6.40	6.40	4	0	BDL	BDL	BDL
Bis(2-Ethylhexyl)phthalate	6	4	BDL	7.60	2.67	2	2	0.94	2.40	1.67
Butylbenzylphthalate	6	0	BDL	BDL	BDL	4	3	BDL	1.60	1.24
Di-n-octylphthalate	6	1	BDL	4.90	4.90	4	0	BDL	BDL	BDL
Di-n-butylphthalate	6	5	BDL	3.80	2.36	2	1	BDL	2.70	2.70
Pesticides:										
Heptachlor	1	1	0.09	0.009	0.009	5	0	BDL	BDL	BDL
Beta-BHC	1	0	BDL	BDL	BDL	5	5	0.008	0.028	0.015

NOTES:

1. * = that this value is greater than average regional background levels
2. BDL = below Detection Limit
3. NA = not analyzed
4. Source: Shacklette and Boerngen, 1984 (unless otherwise specified)
5. Source: Adriano, 1986

Boring W-3b had antimony (22 mg/kg), cadmium (4.8 mg/kg), chromium (1,010-2,116 mg/kg), copper (1135 mg/kg), magnesium (7,500-25,500 mg/kg), mercury (0.4-5.1 mg/kg), nickel (651 mg/kg), silver (8.5 mg/kg) and zinc (506-720 mg/kg) above regional background concentrations. These findings were limited to the upper eight feet except for magnesium, antimony and silver. All other inorganics identified were within or below regional background concentrations.

Boring W-4 had cadmium (2.4 mg/kg), chromium (1,601-1,050 mg/kg) copper (413 mg/kg), and magnesium (7,293-15,100 mg/kg) present above regional background concentrations. However, the magnesium concentrations were not significantly elevated with respect to the background boring. Cyanide (1.4-72 mg/kg) was also detected in W-4 with the highest concentration (72 mg/kg) found within two feet of the surface.

Boring W-5 had concentrations of cadmium (2.7 mg/kg), chromium (1,045-2,508 mg/kg), copper (339-1,396 mg/kg), lead (374-893 mg/kg), mercury (0.5-0.6 mg/kg), magnesium (17,500-19,900 mg/kg), nickel (1521-2957 mg/kg) and zinc (469 mg/kg) above regional background values. In addition, cyanide (61-574 mg/kg) was detected above regional background ranges in the upper eight feet of the boring. Sharp decreases in the concentrations of chromium, lead, cyanide, nickel, copper and barium were observed between the 6-8 and 8-10 foot depth intervals.

Boring W-6 showed concentrations of cadmium (1.2-1.5 mg/kg), copper (105-633 mg/kg), magnesium (6,146-10,600 mg/kg) and silver (2.5-3.3 mg/kg) above regional background values. Once again, the magnesium concentrations observed in this boring were not significantly elevated with respect to the background boring. Concentrations of barium, chromium, nickel and vanadium appear to peak in the 6-11 foot depth interval with sharply decreased concentrations found at greater depths. Cyanide (74 mg/kg) was identified in the upper two feet, while the cadmium, copper and silver exceedances were limited to the upper eight feet.

Boring B-1 had antimony (13 mg/kg), arsenic (62 mg/kg), cadmium (1-1.6 mg/kg), chromium (2,433 mg/kg) copper (181-187 mg/kg), lead (928 mg/kg), and magnesium (7,365-26,200 mg/kg) above regional background concentrations. Cyanide (0.7-4.9 mg/kg) was also identified. Most of the inorganics found were present in the upper 8-10 feet with the exception of magnesium, found throughout the sample, cadmium found at 20-25 feet and cyanide at 45 feet. The data from B-1 show decreasing concentrations of several inorganics as a function of increasing depth. These elements include chromium, arsenic and lead, with the most consistent depth vs. concentration relationship being for chromium.

Boring B-2 had copper (199 mg/kg) and magnesium (7,809-26,300 mg/kg) above regional background concentrations. Once again, the magnesium concentrations were not significantly elevated with respect to the background boring (W-1). No significant relaticnships between concentration of an element and depth of the sample were apparent in boring B-2. Cyanide (0.32-4.4 mg/kg) was identified throughout the boring to a depth of 30 feet below the surface.

Boring B-3 had magnesium (6540-12,500 mg/kg) throughout the boring, however, this was not significant in respect to the concentrations found in the background boring. Cadmium (1 mg/kg) was detected in the upper 6 feet of the boring as well as at a depth of 100 feet below the surface. Mercury was found at concentrations of 0.6 to 2.00 mg/kg at 50 to 60 feet below the surface. Cyanide was found at concentrations up to 0.8 mg/kg at depths of 0 to 6 feet.

Boring B-4 had cadmium (1.4 mg/kg), chromium (2,561-2,968 mg/kg), copper (824-949 mg/kg), nickel (1,159-1,449 mg/kg), magnesium (9,711-27,000 mg/kg) and zinc (435-539 mg/kg) above regional background concentrations. Cyanide (0.4-231 mg/kg) was also found with the highest concentration at 6-8 feet below the surface. The highest concentrations for chromium, copper, nickel and zinc were also detected 6-8 feet below the surface.

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Boring B-5 had copper (133-154 mg/kg), magnesium (7,751 mg/kg) and nickel (517 mg/kg) above regional background concentrations. Cyanide (1.2-124 mg/kg) was identified throughout the boring, with concentrations increasing as a function of depth. No significant relationships between concentration and depth were apparent in boring B-5.

Boring B-6 had cadmium (2.5-9.2 mg/kg), chromium (1207-1423 mg/kg), copper (143-1209 mg/kg), lead (365 mg/kg), magnesium (8636-9326 mg/kg), nickel (576-1022 mg/kg) and zinc (301-1474 mg/kg) above regional background concentrations. Cyanide (0.1-17 mg/kg) was also identified throughout the boring. Cadmium, chromium, copper, lead, and zinc exhibited decreasing concentrations as a function of increasing depth.

Boring B-7 had cadmium (1.6-12 mg/kg), chromium (1,440-3,521 mg/kg), copper (617-10,100 mg/kg), magnesium (6,722-17,700 mg/kg), mercury (0.14-1.6 mg/kg), nickel (1,094-4,520 mg/kg), and zinc (589-2,029 mg/kg) above regional background concentrations. Cyanide (4-15 mg/kg) was also identified 4-8 feet below surface. Chromium, barium, copper, lead, nickel and zinc exhibited sharply increased concentrations between the 0-2 and 2-4 foot depth intervals.

1.2.3.1.3 Volatile Organic Results

Soil samples for volatile organic analyses were collected from four borings at the Site. Volatile organic data is summarized in Table 1-4. The results for W-1 showed the presence of 2-Butanone (58 ug/kg) at 12-21 feet below the surface. The results of samples from boring W-3B showed the presence of methylene chloride (18-32 ug/kg), acetone (14,110 ug/kg), trichloroethene (5596 ug/kg), tetrachloroethene (12 ug/kg), toluene (12-65 ug/kg) and ethylbenzene (6 ug/kg). Most of the volatiles identified were limited to the upper eight feet of the boring. The results for samples from boring B-2 showed the presence of acetone (19-76 ug/kg), 2-butanone (33-57 ug/kg), trichloroethene (34 ug/kg), and toluene (5 ug/kg). These compounds were identified at two feet (2-butanone and toluene), eleven feet (acetone), twenty feet (acetone and trichloroethene), and at thirty

TABLE 1-4

VOLATILE ORGANICS IN SURFACE SOILS

Substance	Boring Depth (ft)	S-W1-4 9-11	S-W1-6 19-21	S-WSB-2 2-4	S-WSB-3B 4-6	S-WSB-4 6-8	S-WSB-5 13.5-15.5	S-WSB-11 44-45.5	S-B1-4 8-10	S-B3-4 8-10
Methylene Chloride		U	U	18	24	5	32	U	870	U
Acetone		R	R	110	U	39	U	14	U	10
Carbon Disulfide		U	U	U	60	25	U	U	U	U
2-Butanone		U	58	85	300	37	U	U	9500	9
1,1,1-Trichloroethane		U	U	6	U	8	U	U	U	U
Trichloroethene		U	U	35	96	U	U	U	U	U
Tetrachloroethene		U	U	12	U	U	U	U	3100	U
Toluene		U	U	65	12	14	U	U	8000	U
Ethylbenzene		U	U	6	U	U	U	U	4200	U
Styrene		U	U	U	U	U	U	U	6400	U
Xylenes		U	U	U	U	U	U	U	31000	U

NOTES:

(1) Only those substances detected in one or more samples are included in this table.
(2) All data in ug/kg.
(3) U = below contract required detection limit.
(4) R = data rejected during validation.

feet (2-butanone). Boring B-1 (at 8-10 feet) showed methylene chloride (870 ug/kg), 2-butanone (9,500 ug/kg), ethylbenzene (4,200 ug/kg), styrene (6,400 ug/kg), toluene (8,000 ug/kg), tetrachloroethene (3,100 ug/kg) and total xylenes (31,000 ug/kg). The sample form B-3 at 8-10 feet identified the presence of acetone (10 ug/kg).

1.2.3.1.4 Semi-volatile and PCB Results

Semivolatiles were analyzed for in samples from borings W-1, W-3b and B-2. The semi-volatile organic data is summarized in Table 1-5. PCB/pesticide data is summarized in Table 1-6. Boring W-1 showed the presence of di-n-butylphthalate (840-1,700 ug/kg) throughout the 0-21 foot depth interval, butylbenzylphthalte (1300 ug/kg) at 11 feet and bis(2-ethylhexyl)phthalate (510-1400 ug/kg) from 0-21 feet. In boring W-3B the semivolatiles identified were phenanthrene (3,000 ug/kg) at 8 feet, di-n-butylphthalate (520-3800 ug/kg) at 0-40 feet, fluoranthene (370-3000 ug/kg) at 0-8 feet, and pyrene (330-3000 ug/kg) at 0-8 feet.

The semivolatiles identified in boring B-2 were phenanthrene (1,700 ug/kg) at 9-11 feet, anthracene (370-1,100 ug/kg) at 0-11 feet, Di-n-Butylphthalate (3,600 ug/kg) at 0-2 feet, fluoranthene (11,000 ug/kg) at 0-2 feet, pyrene (4890-1,600 ug/kg) at 0-11 feet,benzo(a)anthracene (850 ug/kg) at 9-11 feet, bis(2-ethylhexyl)phthalate (940-1,400ug/kg) at 9-11 and 23-25 feet, chrysene (670 ug/kg) at 9-11 feet, benzo(b) fluoranthene (890 ug/kg) at 9-11 feet, and benzo(a)pyrene (440 ug/kg) at 9-11 feet.

Of the borings analyzed for pesticides and PCBs, no PCBs were found and only two pesticides were present. Beta-BHC (9.39-28 ug/kg) was detected at a depth of 29-50 feet and was the only pesticide identified in W-3b. In boring B-2 the pesticide Heptachlor (8.5 ug/kg) was detected at 18-20 feet.

TABLE 1-5 SEMIVOLATILE ORGANICS IN SURFACE SOILS

SAMPLE NUMBER	DEPTH (ft)	Dimethyl phthalate	Di-n-butyl phthalate	Butylbenzyl phthalate	Bis-(2-ethylhexyl) phthalate	Di-n-octyl phthalate	Phen-anthrene	Anthracene	Fluor-anthene	Pyrene	Benzo(a) anthracene	Chrysene	Benzo(b) fluoranthene	Benzo(a) pyrene	Total phthalates	Total Coal tar Constituents
S-B2-1	0-2	U	3600	U	U	U	U	11000	11000	480	U	U	U	U	3600	22480
S-B2-3	9-11	U	U	U	1400	U	1700	370	U	1600	850	670	890	440	1400	6520
S-B2-7	23.5-25	U	U	U	940	U	U	U	U	U	U	U	U	U	940	0
S-W1-2	2-4	U	1700	U	510	U	U	U	U	U	U	U	U	U	2210	0
S-W1-3	4-6	U	1400	U	1400	U	U	U	U	U	U	U	U	U	2800	0
S-W1-4	9-11	U	1300	1300	690	U	U	U	U	U	U	U	U	U	3290	0
S-W1-5	14-16	150	840	U	730	U	U	U	U	U	U	U	U	U	1720	0
S-W1-6	19-21	U	1300	U	570	U	U	U	U	U	U	U	U	U	1870	0
S-W3B-1	0-2	U	520	U	940	U	U	U	410	370	U	U	U	U	1460	780
S-W3B-2	2-4	U	820	U	1100	U	U	U	430	390	U	U	U	U	1920	820
S-W3B-3A	4-6	U	2400	U	7200	U	370	U	370	330	370	330	R	450	9600	2220
S-W3B-3B	4-6	U	3000	U	8000	U	U	U	U	R	U	U	U	360	11000	360
S-W3B-4	6-8	U	1300	U	U	4900	3000	U	3300	3000	1700	1400	2500	U	6200	14900
S-W3B-5	13.5-15.5	U	3800	U	590	U	U	U	U	U	U	U	U	U	4390	0
S-W3B-6	17-19	U	3200	U	U	U	U	R	U	U	U	U	U	U	3200	0
S-W3B-7	24-25.5	U	2700	910	2400	U	U	U	U	U	U	U	U	U	6010	0
S-W3B-8	29-30.5	U	R	1200	R	U	U	U	U	U	U	U	U	U	1200	0
S-W3B-10	39-40.5	U	R	1600	R	U	U	U	U	U	U	U	U	U	1600	0

NOTES

1. All data in ug/kg
2. Only those substances detected in one or more samples are reported in this table.
3. U = below contract required detection limit.
4. R = data rejected during validation

TABLE 1-6

PCBs/PESTICIDES IN SURFACE SOILS

Sample No.	Depth (ft)	beta-BHC	Heptachlor
S-B2-6	18.5-20	U	8.50
S-W3B-8	29-30.5	9.39	U
S-W3B-9	34-35.5	15.00	U
S-W3B-10	39-40.5	15.00	U
S-W3B-11	44-49.5	7.80	U
S-W3B-12	49-50.5	28.00	U

NOTES:

(1) Only those substances detected in one or more samples are included in this table.
(2) All data in ug/kg.
(3) U = below contract required detection limit.

1.2.3.2 **Surface Water**

Surface water sampling during the RI was limited to two samples taken upgradient of the Site and two samples taken adjacent to and slightly downgradient of the Site. Many more sediment samples were taken from areas both upgradient and downgradient of the Site (see Section 1.2.3.3). Four metals (cadmium, copper, lead and nickel) were detected in surface water samples collected downstream of the Site at concentrations which exceeded USEPA Ambient Water Quality criteria. A summary of the analytical results for the surface water samples is presented in Table 1-7.

1.2.3.3 **Sediments**

Table 1-8 summarizes the analytical results for the sediment samples obtained during the RI. As shown in Table 1-8, a number of metals and polycyclic aromatic hydrocarbons (PAHs) were detected in the sediment samples. The PAHs were detected with greatest frequency and magnitude approximately one mile downstream of the Site. Metals, on the other hand, were most prevalent adjacent to and approximately one-half mile downstream of the Site; however, metals were frequently detected in each transect of the River.

Lead was the only substance that was detected at greater concentrations in both downgradient surface water and sediment samples than upgradient, exceeded regional background levels for soils in downgradient sediment samples, and exceeded the Ambient Water Quality criteria in downgradient surface water. Due to the industrial nature of the area, definitive conclusions regarding the origin and transport of lead cannot be drawn; however, the Auto Ion Site may have contributed or may currently be contributing to, elevated levels of lead and other substances in the River.

TABLE 4

ANALYTICAL SUMMARY - SURFACE WATER SAMPLES

	Concentrations Upgradient (mg/l)(1)		Concentrations Downgradient (mg/l)(1)	
	SW-A-1	SW-A-4	SW-D-1	SW-D-4
Organics				
Acetone	U	U	0.044	0.020
Bis(2-ethylhexyl)phthalate	0.420	0.198	0.094	0.140
Inorganics				
Aluminum	U	U	0.219	0.207
Cadmium	U	U	0.013	0.012
Calcium	74.0	73.25	76.8	77.0
Chromium III	0.007	U	0.039	0.037
Copper	U	U	0.032	0.032
Iron	0.46	0.327	0.527	0.392
Lead	U	U	0.193	0.199
Magnesium	22.2	22.0	22.2	22.3
Manganese	0.040	0.049	0.058	0.048
Nickel	U	U	0.060	0.061
Silver	U	U	0.27	0.28
Zinc	0.013	0.014	0.026	U

NOTES:

(1) Sample locations are shown in Figure 3-1 of the Remedial Investigation report.
(2) U = below required detection limits.
(3) Only those substances detected in one or more samples are included in this table.

TABLE 3

ANALYTICAL SUMMARY - SEDIMENT SAMPLES
ALL DATA IN (mg/kg)

Parameter	TRANSECT A (Upgradient of Site) Number of Samples	Number Positive IDs	Sample Range Low	Sample Range High	Sample Mean	TRANSECTS B, C and D (Adjacent to Site) Number of Samples	Number Positive IDs	Sample Range Low	Sample Range High	Sample Mean
Inorganics:										
Aluminum	4	4	952.00	1377.00	1112.50	12	12	663.00	2620.00	1378.67
Arsenic	4	1	BDL	2.00	2.00	12	2	BDL	5.60	4.05
Barium	4	0	BDL	BDL	BDL	12	2	BDL	95.00*	78.50*
Cadmium	4	0	BDL	BDL	BDL	12	0	BDL	BDL	BDL
Chromium	4	4	16.00	19.00	17.75	12	12	12.00	113.00*	26.13
Copper	4	2	BDL	14.00	10.00	12	8	BDL	117.00*	26.65
Iron	4	4	3668.00	5784.00	4400.50	12	12	4156.00	21461.00*	9093.50
Lead	4	4	11.00	18.00	14.25	11	11	8.00	208.00*	49.65
Magnesium	4	4	3666.00	9219.00	6849.00	12	12	6671.00	36500.00*	13095.08*
Manganese	4	4	192.00	259.00	228.50	12	12	131.00	294.00	221.50
Mercury	4	0	BDL	BDL	BDL	12	7	BDL	2.90*	0.61*
Nickel	4	1	BDL	16.00	16.00	12	2	BDL	18.00	15.00
Thallium	4	0	BDL	BDL	BDL	12	0	BDL	BDL	BDL
Vanadium	4	0	BDL	BDL	BDL	12	1	BDL	15.00*	15.00*
Zinc	4	4	23.00	38.00	31.00	12	12	17.00	82.00	48.75
Organics:										
Acetone	1	1	0.07	0.07*	0.07*	2	0	BDL	BDL	BDL
2-Butanone	4	0	BDL	BDL	BDL	12	1	BDL	0.01*	0.01*
Anthracene	4	0	BDL	BDL	BDL	11	2	BDL	0.81*	0.61*
Benzo(a)anthracene	4	0	BDL	BDL	BDL	11	3	BDL	2.00	1.11
Benzo(a)pyrene	4	0	BDL	BDL	BDL	11	3	BDL	1.60	0.90
Benzo(b)fluoranthene	4	0	BDL	BDL	BDL	11	3	BDL	2.10	1.14
Benzo(k)fluoranthene	4	0	BDL	BDL	BDL	12	2	BDL	1.00	0.90
Chrysene	4	0	BDL	BDL	BDL	11	3	BDL	1.90	1.04

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TABLE 1-8 (CONTINUED)

Parameter	TRANSECT E (1/2-Mile Downgradient of Site) Number of Samples	Number Positive IDs	Sample Range Low	High	Sample Mean	TRANSECT F (One Mile Downgradient of Site) Number of Samples	Number Positive IDs	Sample Range Low	High	Sample Mean
Inorganics:										
Aluminum	3	3	1410.00	2870.00*	2330.00*	3	3	1460.00	2550.00	2033.33
Arsenic	3	3	3.20	9.00*	6.03*	3	2	BDL	6.50	4.65
Barium	3	1	BDL	65.00	65.00	3	0	BDL	BDL	BDL
Cadmium	3	3	1.60	3.80*	2.47*	3	0	BDL	BDL	BDL
Chromium	3	3	26.00	31.00	28.00	3	3	22.00	54.00	33.00*
Copper	3	3	13.00	66.00	41.33*	3	3	9.00	44.00	21.33
Iron	3	3	6760.00	16700.00	13220.00*	3	3	6850.00	10800.00	8190.00
Lead	3	3	75.00	99.00	83.67*	3	3	26.00	189.00	82.00
Magnesium	3	3	7670.00	8420.00	8153.33	3	3	4530.00	10200.00	6983.33
Manganese	3	3	140.00	415.00*	261.00*	3	3	142.00	336.00	216.67
Mercury	3	3	0.14	0.22	0.18	3	1	BDL	0.47	0.47
Nickel	3	3	14.00	19.00*	16.67*	3	2	BDL	13.00	12.50
Thallium	3	1	BDL	0.50*	0.50*	3	0	BDL	BDL	BDL
Vanadium	3	1	BDL	14.00	14.00	3	0	BDL	BDL	BDL
Zinc	3	3	43.00	82.00	65.00	3	3	37.00	160.00*	78.67*
Organics:										
Acetone	3	0	BDL	BDL	BDL	2	1	BDL	0.02	0.02
Acenaphthylene	3	0	BDL	BDL	BDL	3	1	BDL	0.90*	0.90*
Acenaphthene	3	1	BDL	0.33*	0.33*	3	0	BDL	BDL	BDL
Anthracene	3	3	0.35	0.81	0.60	3	2	BDL	2.10*	1.22*
Benzo(a)anthracene	3	3	0.78	2.40	1.53	3	2	BDL	4.60*	2.80*
Benzo(a)pyrene	3	3	0.65	2.20	1.38	3	2	BDL	2.60*	1.69*
Benzo(b)fluoranthene	3	3	0.87	3.20*	1.79*	3	1	BDL	0.69	0.69
Benzo(k)fluoranthene	3	0	BDL	BDL	BDL	3	2	BDL	7.00*	3.74*
Chrysene	3	3	0.78	2.30*	1.46*	3	1	BDL	0.87	0.87

1.2.3.4 Groundwater

Groundwater at the Auto Ion Site is not currently used as a source of drinking water. A municipal well field is located approximately one mile north of the site in the opposite direction of apparent groundwater flow.

Tables 1-9 and 1-10 summarize the analytical results for the groundwater samples obtained during the RI. The following observations were made based on the analyses conducted. Semivolatiles detected in both soils and river water sediments were not found to be present in groundwater. No pesticides or PCBs were detected in groundwater samples. A number of metals including barium, cadmium, chromium, lead, and mercury exceeded their corresponding MCLs. Copper and iron exceeded the respective corresponding secondary drinking water standard. Analysis of well W-3b, penetrating the deep aquifer indicates comparatively lower levels of inorganic constituents and an absence of organic compounds.

1.2.4 Summary of Contaminant Distribution

The fate and transport of hazardous substances in the soils, surface water, sediment and groundwater at the Site was described in the RI report. An overview of the distribution of hazardous substances in the soils is presented in this section, since the FS for Operable Unit One is focused on soil contamination at the Site.

The presence of elevated concentrations of several heavy metals with respect to average regional background concentrations, appears to be the most significant problem in the soils at the Site. The heavy metals of concern include arsenic, barium, cadmium, chromium, copper, lead, nickel and zinc. The presence of these elements is consistent with the plating waste management activities conducted during part of the history of the facility. For the most part, the heavy metals appear to be localized in the northwestern portion of the property in the vicinity of borings B-1,

TABLE 1-9

ANALYTICAL SUMMARY - GROUNDWATER SAMPLES
ALL DATA IN (mg/l)

Parameter	Round I Number of Samples	Round I Number Positive IDs	Round I Sample Range Low	Round I Sample Range High	Round I Sample Mean	Round II Number of Samples	Round II Number Positive IDs	Round II Sample Range Low	Round II Sample Range High	Round II Sample Mean
Inorganics:										
Aluminum	5	3	BDL	74.60	38.20	5	5	4.68	71.70	26.04
Arsenic	5	3	BDL	0.05	0.03	5	5	0.01	0.04	0.03
Barium	5	2	BDL	4.34	2.53	5	2	BDL	4.52	2.63
Beryllium	5	2	BDL	0.11	0.06	5	0	BDL	BDL	BDL
Cadmium	5	3	BDL	0.04	0.02	5	5	0.03	0.02	0.01
Chromium III	5	3	BDL	1.31	0.78	5	5	0.22	1.37	0.78
Chromium VI	5	0	BDL	BDL	BDL	5	1	BDL	0.13	0.13*
Cobalt	5	2	BDL	0.31	0.19	5	2	BDL	0.13	0.09
Copper	4	2	BDL	0.64	0.56	3	2	BDL	1.16	0.85*
Cyanide	5	5	0.01	2.78	0.60	5	4	BDL	0.12	0.07
Iron	4	3	BDL	114.00	53.52	5	5	2.05	278.00	68.96*
Lead	4	2	BDL	0.57	0.48	5	5	0.05	0.24	0.13
Magnesium	5	5	24.30	209.00	74.52	5	5	35.55	100.00	138.00*
Manganese	4	4	1.27	11.20	3.81	5	5	0.002	0.04	0.01
Mercury	5	2	BDL	0.0015	0.0012	5	3	BDL	0.0027	0.0014
Nickel	5	5	0.27	5.23	2.54	5	5	0.60	12.30	5.73*
Silver	5	1	BDL	0.01	0.01	5	0	BDL	BDL	BDL
Vanadium	5	1	BDL	0.06	0.06	5	4	BDL	0.18	0.08*
Zinc	4	4	0.03	0.86	0.47	5	5	0.54	4.91	1.67*

TABLE 1-9
(Continued)

ANALYTICAL SUMMARY - GROUNDWATER SAMPLES
ALL DATA IN (mg/l)

	Round I					Round II				
Parameter	Number of Samples	Number Positive IDs	Sample Range Low	Sample Range High	Sample Mean	Number of Samples	Number Positive IDs	Sample Range Low	Sample Range High	Sample Mean
Organics:										
Chloroform	5	2	BDL -	0.09	0.05	5	2	BDL -	0.03	0.02
Trichloroethene	5	4	BDL -	0.41	0.13	5	2	BDL -	0.16	0.12
Trans-1,2-Dichloroethene	5	2	BDL -	0.17	0.13	5	2	BDL -	0.12	0.068
1,2-Dichloroethane	5	1	BDL -	0.05	0.05	5	0	BDL	BDL	BDL
1,2-Dichlorobenzene	5	1	BDL -	0.02	0.02	5	0	BDL	BDL	BDL
2,4,6-Trichlorophenol	5	1	BDL -	0.02	0.02	5	0	BDL	BDL	BDL
Vinyl Chloride	5	3	BDL -	0.04	0.02	5	0	BDL	BDL	BDL
Methylene Chloride	5	3	BDL -	0.56	0.19	3	0	BDL	BDL	BDL
Bis(2-ethylhexyl)phthalate	5	5	0.02 -	0.16	0.06	5	0	BDL	BDL	BDL
Di-n-butylphthalate	5	3	BDL -	0.14	0.11	5	0	BDL	BDL	BDL

TABLE 1-10

ANALYTICAL SUMMARY - DEEP AND BACKGROUND GROUNDWATER SAMPLES

Parameter	Deep Monitoring Well W-3b Round I (1)	Deep Monitoring Well W-3b Round II (2)	Background Monitoring Well W-1 Round I	Background Monitoring Well W-1 Round II
Inorganics:				
Aluminum	ND	0.068*	ND	38.6*
Barium	ND	ND	ND	0.384*
Beryllium	ND	0.0042*	ND	ND
Cadmium	ND	ND	ND	0.013*
Chromium III	ND	0.019*	ND	0.277*
Cobalt	ND	ND	ND	0.071*
Cyanide	0.013	0.07*	ND	ND
Iron	ND	2.05*	ND	222*
Lead	ND	0.008*	ND	0.200*
Magnesium	47.2	46.3	41.8	11.7
Manganese	0.255	0.234	0.016	5.37*
Mercury	ND	ND	ND	0.0003*
Nickel	0.211	0.032	ND	0.225*
Vanadium	ND	ND	ND	0.108*
Zinc	0.032	ND	ND	0.521*
Organics:				
Tetrachloroethylene	ND	ND	ND	0.006*
Bis(2-ethylhexyl) phthalate	0.024	ND	0.024	ND
Di-n-butylphthalate	0.12	ND	0.15	ND

NOTES:

All values in mg/l.
ND = Not Detected.
(1) Round I samples collected in November, 1987.
(2) Round II samples collected in April, 1988.
* Indicates that this parameter was detected at a mean concentration in Round II greater than the mean concentration in Round I.

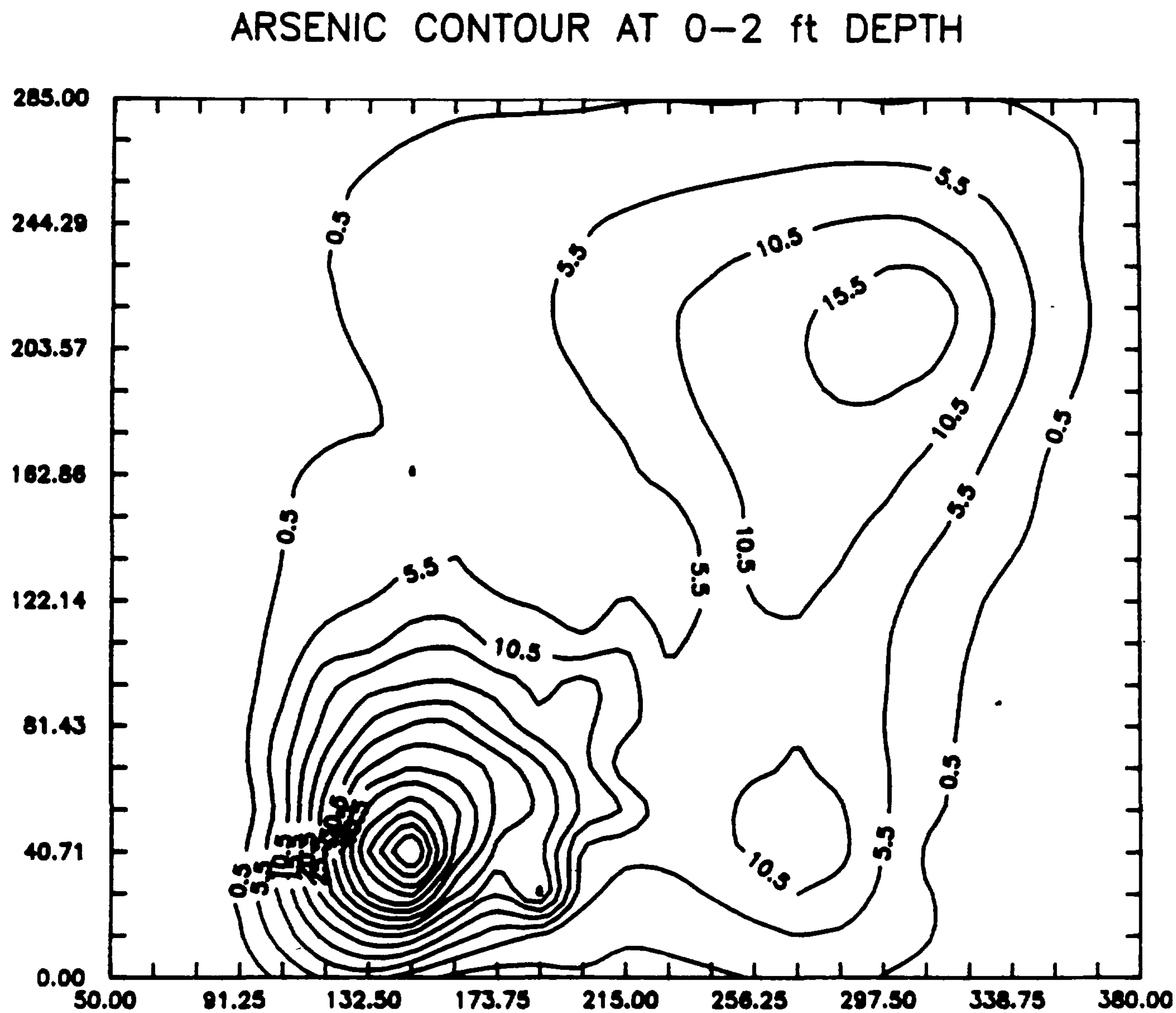
B-4, B-5, B-6, B-7, and wells W-3a and W-3b (see Figures 1-8 through 1-10). In many cases, these metals show decreasing concentrations as a function of increasing depth. Figure 1-11 illustrates this concentration vs. depth relationship for chromium in Boring B-1. The inverse relationship between concentration and depth is also apparent when examining arsenic, chromium, copper, lead, cyanide and nickel as a combined indication of plating waste contamination (see Figure 1-12).

Organic contamination of soils at the Site appears to be somewhat sporadic and of limited extent. Volatile organics found include methylene chloride, acetone, carbon disulfide, 2-Butanone, 1,1,1,-Trichloroethane, trichloroethene, tetrachloroethene, toluene, ethylbenzene, styrene and xylenes. Samples collected from W-3b showed some evidence of a relationship between contaminant concentrations and increasing depth. With increasing depths, concentrations of carbon disulfide, 2-butanone, and trichloroethene increase to a maximum in the 4-6 foot depth interval, then decrease thereafter. The greatest concentrations and greatest number of volatile organics detected both occurred in boring B-1. This correlates well with the inorganic data, which also showed that boring B-1 had the greatest concentrations of several inorganics.

A number of semivolatile organics were found in the soils at the Site. The substances found were mainly of the coal-tar constituent family, and of the phthalate family. Data from W-3b indicate that the greatest number (and in some cases, concentration) of semivolatile organics occur in the 4-8 foot depth interval. Decreasing concentrations of these substances were generally found at greater depths.

No PCBs were found in the soils at the Site. Pesticides found at the Site include heptachlor in boring B-2 and beta-BHC in boring B-3.

FIGURE 1-8



ARSENIC CONTOUR AT 0-2 ft DEPTH
285.00
244.29
203.57
162.86
122.14
81.43
40.71
0.00
50.00
91.25
132.50
173.75
215.00
256.25
297.50
338.75
380.00
0.5
5.5
10.5
15.5

FIGURE 1-9

ARSENIC CONTOUR AT 2-4 ft DEPTH

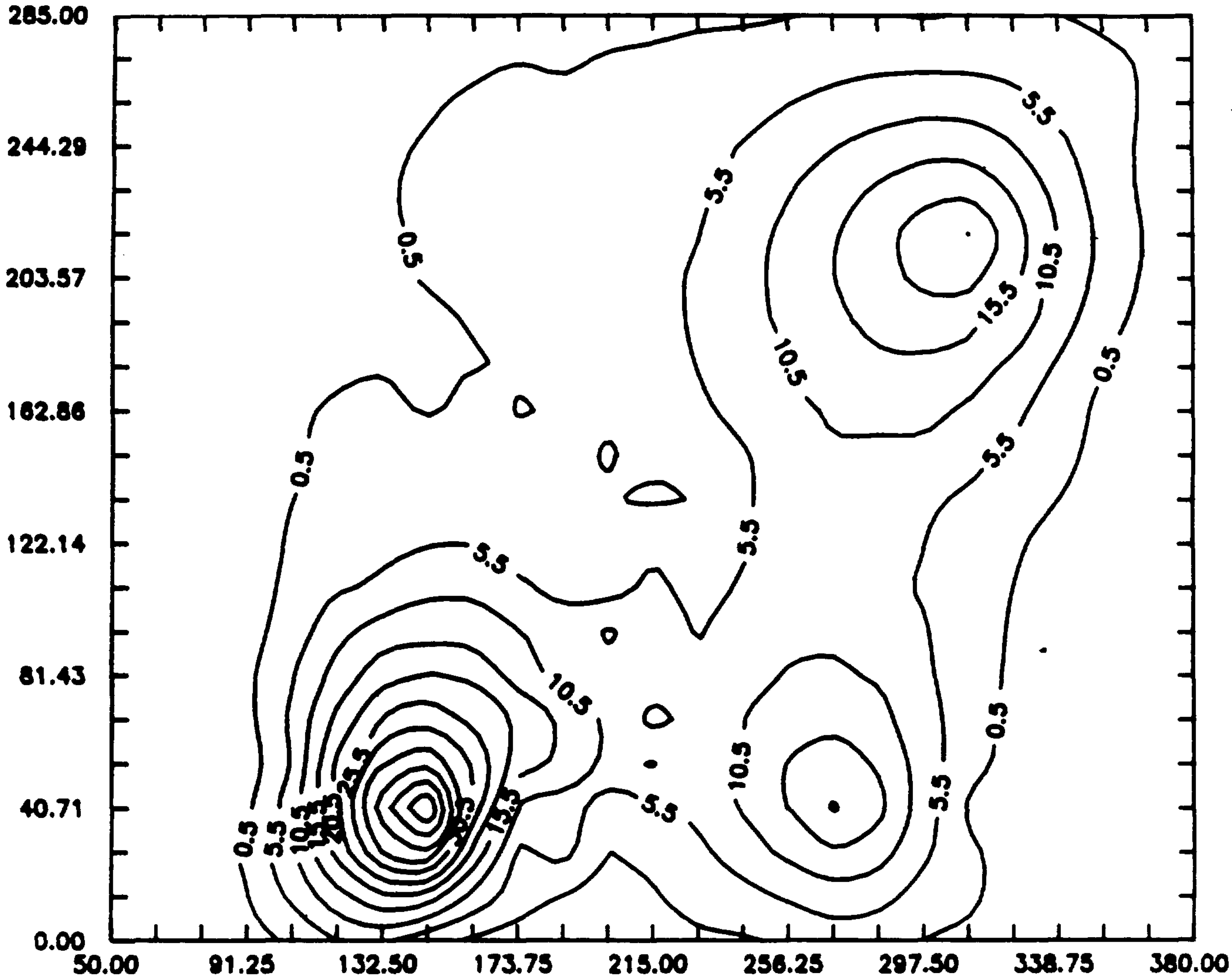


FIGURE 1-10

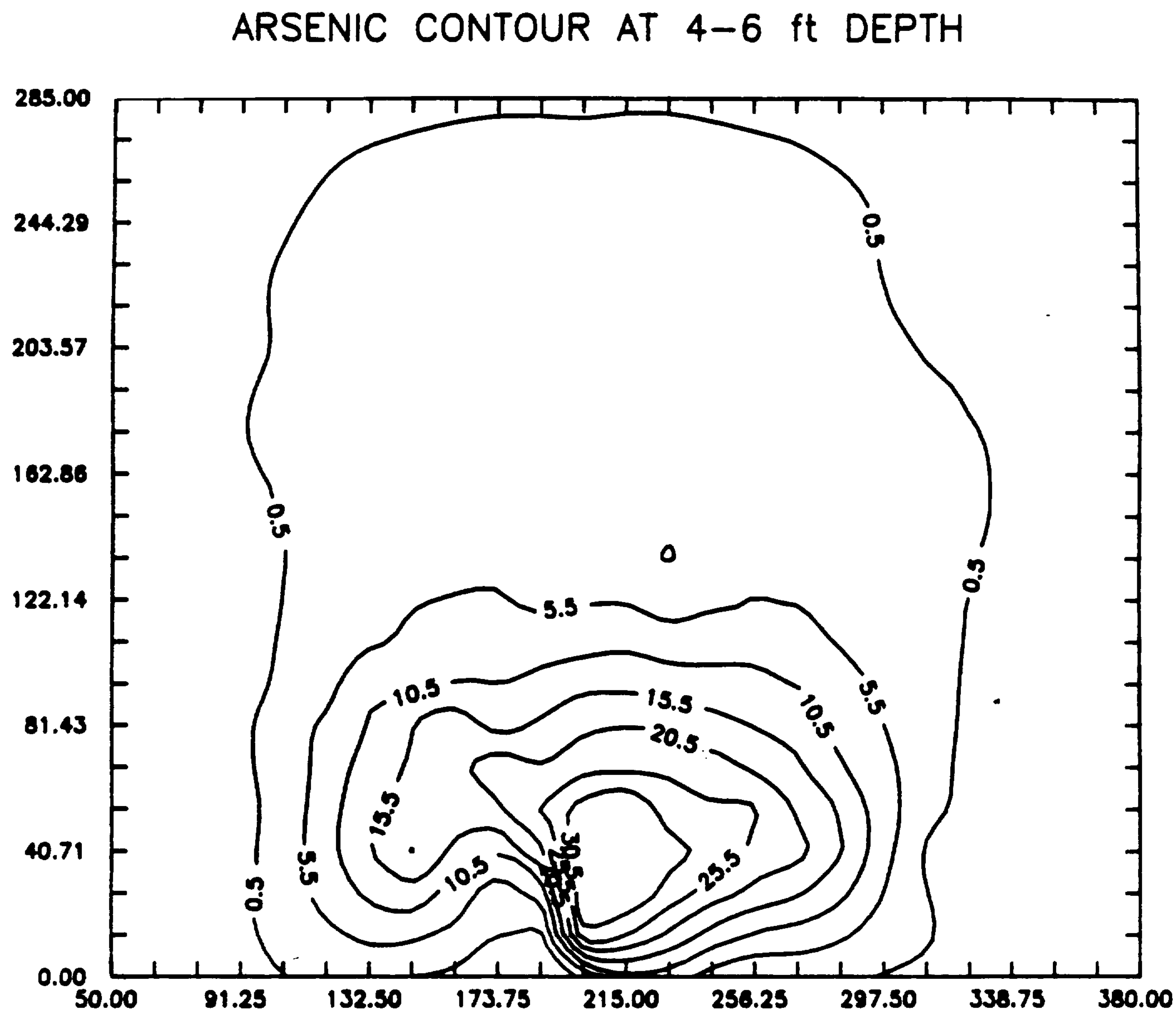

ARSENIC CONTOUR AT 4-6 ft DEPTH
285.00
244.29
203.57
162.86
122.14
81.43
40.71
0.00
50.00
91.25
132.50
173.75
215.00
256.25
297.50
338.75
380.00
0.5
5.5
10.5
15.5
20.5
25.5
30.5

FIGURE 1-11

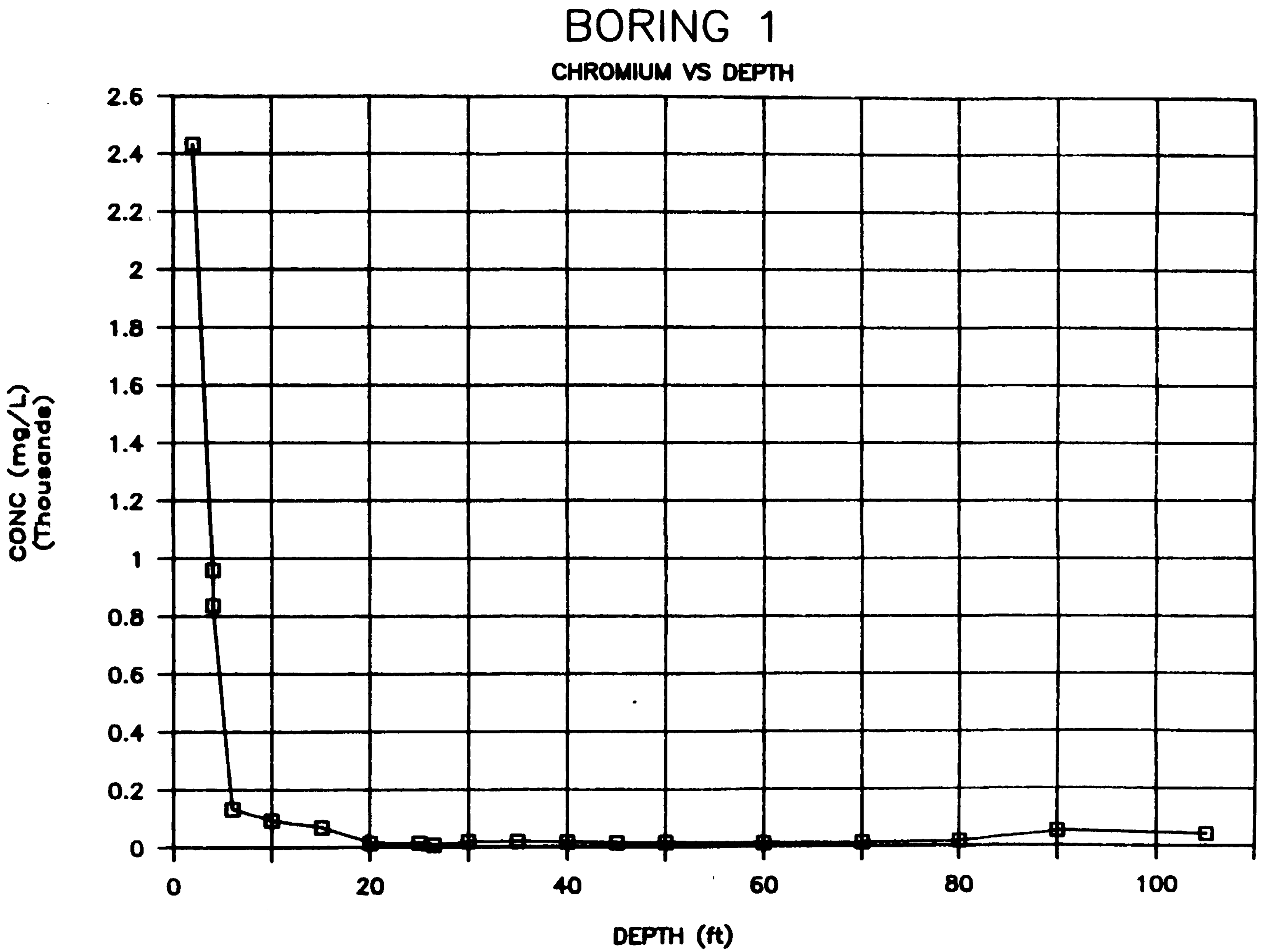
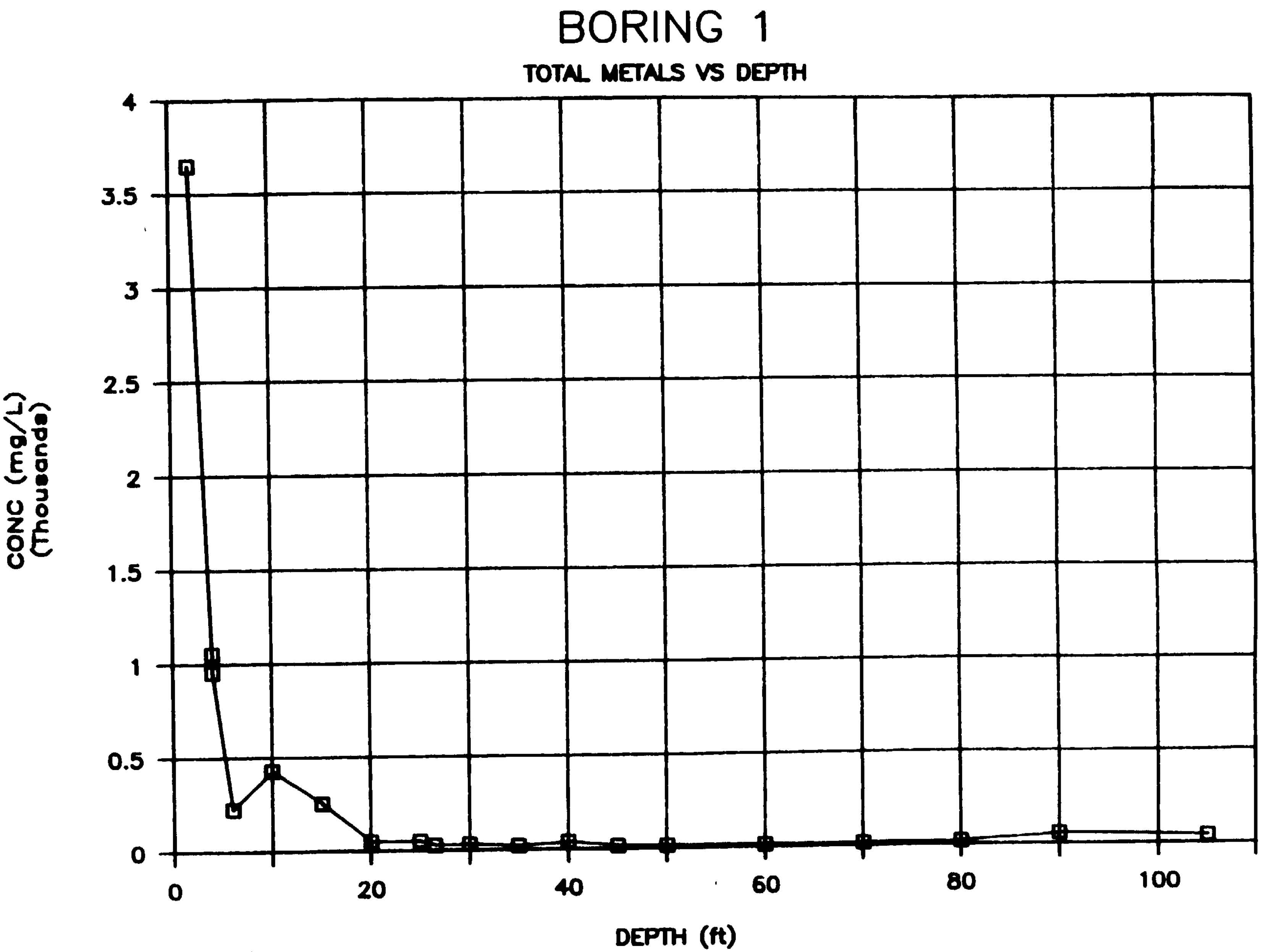

BORING 1
CHROMIUM VS DEPTH
CONC (mg/L)
(Thousands)
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
20
40
60
80
100
DEPTH (ft)

FIGURE 1-12


BORING 1
TOTAL METALS VS DEPTH
CONC (mg/L)
(Thousands)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
DEPTH (ft)

1.2.5 Summary and Conclusions of the Endangerment Assessment

The purpose of the Endangerment Assessment (EA) was to define the risks posed to human health and the environment by hazardous substances present at the Site. The EA process consists of defining:

- the source of the risk;
- the exposure pathway(s) those substances could take to reach humans or the environment; and
- humans, aquatic life or wildlife that could come into direct contact with, inhale or ingest those substances.

The result of the EA was a quantitative assessment of the potential health risk that the Site poses to humans and the environment. If the level of risk is judged to be unacceptable, then remedial actions must be implemented to alter the source, pathway or receptor to reduce the risk to acceptable levels.

In order to fulfill the requirements of an endangerment assessment, it was not necessary to thoroughly evaluate all of the hazardous substances detected at the Site in terms of their concentrations, migration potential in various media, adverse health effects, degree of exposure and implications for public health. Certain indicator chemicals were selected for the assessment based on the assumption that evaluation of these indicator chemicals will provide a representative analysis of Site conditions. The indicator chemicals chosen for the Site were arsenic, barium, cadmium, copper, lead, nickel, cyanide, trichloroethylene, bis(2-ethylhexyl)phthalate and polycyclic aromatic hydrocarbons (PAHs).

1.2.5.1 Exposure Pathways

Although the Site is currently inactive and changes are not foreseen in the immediate future, potential carcinogenic health risks and chronic health hazards were evaluated for the Site in its current state and under potential future use conditions. A summary of present and future potential exposure pathways and risks are described in the sections that follow.

Under current conditions, the following pathways may be complete at the Site:

- dermal contact with surface soil,
- incidental ingestion of surface soil,
- occasional inhalation of airborne dust generated from surface soil.

However, under current and future potential conditions, the dermal contact, soil ingestion and inhalation pathways may not be complete during the winter months because of the snow cover which is generally present at the Site during the winter season. The lack of a thick vegetative cover at the Site and the presence of compounds of concern in surface soils suggests that airborne dust may be generated which contains contaminants of concern. However, the Site is located in an industrial area and access is restricted due to the presence of a fence. This will substantially diminish potential current exposure scenarios under which residents (young children or adults) playing or working on the Site would have measurable contact with Site soils. Since future conditions at the Site are currently unknown, this exposure pathway was evaluated via a hypothetical future scenario. However, projected future Site uses, such as residential development, are unlikely to occur based on site history. Additionally, most residential development would be precluded based on the Site's location in the 100 year floodplain.

Therefore, there are few, if any future use scenarios under which adults and children would have any measurable exposure to Site soil concentrations via the dermal contact, inhalation or ingestion route.

At present, groundwater is not an exposure pathway because no drinking water wells exist on the Site and a well-developed municipal water supply system serves as a source of potable water. Based on the nature of the site, its location and history, it is unlikely that such a well will be installed on the Site in the forseeable future. There is limited potential for exposure via ingestion of shallow aquifer groundwater since the Site's location in a 100-year floodplain precludes any future development at the Site. Flood events have the potential to serve as a source of historical and future site releases. Based on flood profiles obtained from the Michigan Department of Natural Resources projected flood levels are:

- 10 year = 760.5 ft;
- 50 year = 762 feet;
- 100 year = 763 feet;
- 500 year = 764.5 feet.

Additional information on the 100 year flood plain boundary is located in Appendix XI of the EA report. Even though ingestion of the shallow aquifer groundwater underlying the site is not presently an exposure pathway, US EPA Region V required that risk calculations be performed for this pathway under a future potential exposure scenario.

Human exposure to substances of concern at the Site via surface water are thought to be minimal since surface water is not a source of drinking water in this area and only recreational fishing is allowed in this region of the river. There is a ban on most fish consumption in the Kalamazoo

River since the River is on the State of Michigan's 307 List[1]. The 307 listing for the River begins one mile upstream of the Auto Ion Site and continues downstream to Lake Michigan, a distance of eighty miles.

The source of contamination in the River is thought to be paper products surface discharge; landfills are considered the source of PCBs. Resources affected include sediments, groundwater, surface water, soil, flora and fauna in the vicinity of the River. Swimming in this area of the river is also not likely due to a number of waste disposal and sewage disposal areas located in the vicinity of the Site. However, the surface water pathway could be significant for aquatic organisms because the River sediments contain numerous substances of concern. However, other industrial sources in the vicinity of the Site may also be contributing contaminants to the River. Upstream industrial sources include the following areas:

- two waste disposal ponds for a local paper mill located southeast of the Site, on the west bank of the Kalamazoo River,
- a series of sewage disposal ponds located southeast of the Site, on the east bank of the Kalamazoo River,
- two wastewater treatment sewage disposal areas for the City of Kalamazoo located upstream of the Site, adjacent to the River.

A waste disposal area and a sewage disposal area are located downstream of the Site, on the west bank of the Kalamazoo River.

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[1]Michigan Public Act 307 (the Michigan Environmental Response Act) provides for the identification, risk assessment and priority evaluation of environmental contamination sites in the State. Sites are ranked according to their present conditions and more emphasis is placed on existing human exposure to pollutants than the Federal Superfund program. As of September 30, 1987, the Kalamazoo River is listed as number three on the State's 307 list

1.2.5.2 Risk Characterization

Health risks potentially posed by contaminants at the Site were quantitatively evaluated for the following pathways: ingestion of soil, inhalation of airborne soil particles, dermal contact with soil and ingestion of groundwater. Carcinogenic risk calculations were performed for potential adult exposures, as cancer is primarily a chronic disease of adulthood. This results in a conservative calculation of carcinogenic risk as suggested by EPA's contractor. For noncarcinogens, a hazard ratio greater than one was deemed unacceptable. As required by EPA Region V, a risk level greater than 1.0×10^{-6} was deemed unacceptable for carcinogens.

1.2.5.3 Dermal Contact

For dermal contact with on-Site soils under current conditions, calculated carcinogenic cumulative risk levels for adults were less than 1.0×10^{-6} under both the most probable case (1.57×10^{-9}) and the realistic worst case (9.73×10^{-8}). The calculated noncarcinogenic risk levels for chronic health hazards associated with dermal contact with on-Site soils under current conditions, were less than 1.0 for both children (most probable case = 4.62×10^{-2}; realistic worst case = 2.91×10^{-1}) and adults (most probable case = 1.27×10^{-2}; realistic worst case = 4.82×10^{-2}).

For dermal contact with on-Site soils under potential future conditions, calculated carcinogenic risk levels for adults were less than 1.0×10^{-6} under both the most probable case (2.00×10^{-8}) and the realistic worst case (6.21×10^{-7}) scenario. The calculated noncarcinogenic risk levels associated with dermal contact with on-Site soils under potential future conditions, were less than 1.0 for both children (most probable case = 4.62×10^{-2}; realistic worst case = 2.91×10^{-1}) and adults (most probable case = 1.27×10^{-2}; realistic worst case = 4.82×10^{-2}).

(CL5203B/3)

1.2.5.4 Soil Ingestion

Potential risks via soil ingestion were calculated for both children and adults. Children were assumed to ingest 200 mg of soil per day; adults were assumed to ingest 100 mg of soil per day. These soil ingestion rates were based on EPA's Interim Final Guidance on Soil Ingestion Rates (Porter, January 27, 1989).

For exposure via soil ingestion for adults, the calculated carcinogenic risk levels exceeded 1.0×10^{-6} under both the most probable case (6.1×10^{-5}) and realistic worst case scenarios (8.82×10^{-5}). Carcinogenic risk calculations for adults were primarily induced by arsenic and subsurface concentrations of PAHs in soil. However, there are numerous discrepancies and uncertainties associated with the potential carcinogenic risks of arsenic. Arsenic is a natural component of the human diet and calculations performed using estimated daily dietary intake concentrations (ATSDR, 1987) produced carcinogenic risks ranging from 1.93 $\times 10^{-2}$ (900 ug/day) to 4.29×10^{-4} (20 ug/day). Furthermore, carcinogenic risks greater than 1.0×10^{-6} were calculated based on ingestion of soil at concentrations equal to average regional background levels (6.5 mg/kg) in soil (calculated risk = 3.28×10^{-5}).

The calculated noncarcinogenic risk levels due to exposure by soil ingestion, were greater than 1.0 for children under both the most probable case (1.78) and the realistic worst case (1.88) scenario, but were less than 1.0 for adults under both the most probable case (0.217) and realistic worst case (0.229). For children, lead constitutes the main component of this value, with a hazard ratio of 1.39 under both the most probable and realistic worst case scenarios.

1.2.5.5 Inhalation

It was not possible to calculate actual potential inhalation health hazards or carcinogenic risks due to the fact that air sampling data was not collected during the RI. In order to calculate predicted inhalation exposures, the concentration of the indicator chemicals in surface soil was used to predict the concentration of that chemical in air. Three conservative assumptions were used in this analysis:

- the percentage of the chemical in surface soil is equivalent to the percentage of the substance in air;

- all material in the air is respirable (i.e., has a diameter of 10 microns or less);

- an individual will be on-Site for 24 hours each day of their life.

These assumptions suggest that the calculated risks for the inhalation pathway greatly over-estimate the actual risk and that theoretical exposures greatly over-estimate actual levels. Chronic daily intakes via inhalation were calculated for a 70 kg adult breathing 20 m^3 of air per day, and for a 10 kg child breathing 5 m^3 of air per day.

Carcinogenic risks to adults via inhalation exceeded 1.0×10^{-6} under both most probable (1.50×10^{-5}) and realistic worst case (1.80×10^{-5}) scenarios. Arsenic was the only contaminant to pose a risk greater than 1×10^{-6}. None of the selected indicator chemicals were calculated to pose chronic noncarcinogenic health hazards to children or adults using the theoretical exposures for the inhalation pathway under either the most probable case or the realistic worst case scenarios.

Calculated exposure levels were compared to Michigan acceptable ambient air standards for carcinogens and noncarcinogens. Arsenic was the only substance whose calculated exposure level exceeded MDNR's acceptable ambient air standards for the compound as a carcinogen.

1.2.5.6 Groundwater Ingestion

Groundwater at the Auto Ion Site is not currently used as a source of drinking water, and the presence of a well-developed municipal water supply system suggests that it will not be used for such a purpose in the future. Although groundwater in the vicinity of the Site is not currently used as a source of drinking water, nor are projected future uses as a drinking water supply likely, MCLs or a benchmark risk level of 1×10^{-6} were used as guidelines for concentrations of contaminants in groundwater. A municipal well field is located approximately one-mile north of the Site in the opposite direction of groundwater flow.

For ingestion of groundwater under potential future conditions, calculated noncarcinogenic health hazards were greater than one for children under both the most probable case (24.9) and the realistic worst case (31.1) scenarios. Several metals (arsenic, barium, cadmium, lead, and nickel) were calculated to pose a chronic hazard ratio greater than 1.0 under the most probable case scenarios. Under the realistic worst case scenario, chromium (VI) and cyanide were calculated to individually pose a chronic health hazard ratio greater than one.

Groundwater ingestion by adults was calculated to pose a chronic health hazard index of 12 under the most probable case and 15 under the realistic worst case scenario. Under the most probable case scenario, lead and nickel were calculated to individually pose hazard ratios exceeding one; barium was calculated to pose a hazard ratio greater than one under the realistic worst case scenario.

For groundwater ingestion under potential future conditions, calculated carcinogenic risk levels for adults were greater than 1×10^{-6} under both the most probable case (1.68×10^{-3}) and the realistic worst-case (3.05×10^{-3}) scenarios. Each of the five indicator chemicals was calculated to pose an individual risk greater than 1×10^{-6}. Arsenic was detected in only one well at a concentration equal to its MCL.

(CL5203B/3)

However, even at this concentration (0.05 mg/L) which is considered protective of drinking water at a national level, arsenic represents a 1 x 10^{-3} carcinogenic risk and an unacceptable chronic health hazard at the Site.

Calculated carcinogenic risk levels for vinyl chloride range from 1.32 x 10^{-3} to 3.95 x 10^{-4} in Site groundwater. However, the MCL for vinyl chloride (0.002 mg/l, which is based on the practical quantitation level) is equivalent to a 1 x 10^{-4} risk level and is considered protective of human health for consumption of drinking water.

1.2.5.6 Additive Risk

Pathway specific risks for soil ingestion, inhalation, direct contact, and groundwater ingestion under current and future potential conditions were summed to develop a cumulative risk number for carcinogenic risks and chronic health hazards for each potentially affected population based on contaminants found at the Site.

Under current conditions, the soil ingestion, inhalation and direct contact pathway was considered in cumulative risk. Tables 1-11 and 1-12 summarize cumulative risks for noncarcinogenic chronic health hazards and carcinogenic risks under current conditions. Calculated cumulative noncarcinogenic risk levels were greater than 1.0 for children under both most probable (1.86) and realistic worst case (2.21) scenarios. The cumulative noncarcinogenic health hazard level was less than 1.0 for adults under both most probable and realistic worst case scenarios. For current conditions, cumulative carcinogenic risk for adults exceeded 1 x 10^{-6} under both most probable (7.6 x 10^{-5}) and realistic worst case (1.06 x 10^{-4}) scenarios.

TABLE 1-11

CUMULATIVE RISK FOR
NONCARCINOGENIC CHRONIC HEALTH HAZARDS
UNDER CURRENT CONDITIONS

	Children		Adult	
Pathway	Most Probable Case	Realistic Worst Case	Most Probable Case	Realistic Worst Case
Soil Ingestion	1.78×10^{0}	1.88×10^{0}	2.17×10^{-1}	2.29×10^{-1}
Inhalation	3.37×10^{-2}	4.27×10^{-2}	1.92×10^{-2}	2.44×10^{-2}
Direct Contact	4.62×10^{-2}	2.91×10^{-1}	1.27×10^{-2}	4.82×10^{-2}
TOTAL	1.86×10^{0}	2.21×10^{0}	2.49×10^{-1}	3.02×10^{-1}

TABLE 1-12

CUMULATIVE RISK FOR
CARCINOGENIC RISK FOR ADULTS
UNDER CURRENT CONDITIONS

Pathway	Most Probable Case	Realistic Worst Case
Soil Ingestion	6.10×10^{-5}	8.82×10^{-5}
Inhalation	1.50×10^{-5}	1.80×10^{-5}
Direct Contact	1.57×10^{-9}	9.73×10^{-8}
TOTAL	7.60×10^{-5}	1.06×10^{-4}

(CL5178B/2)

Pathways considered for cumulative risk for potential future Site conditions include soil ingestion, groundwater ingestion, direct contact and inhalation (Tables 1-13 and 1-14). Calculated cumulative risk levels for noncarcinogenic chronic health hazards were greater than 1.0 for both children and adults under most probable (children: 2.67, adults: 12.2) and realistic worst case (children: 33.5, adults: 15.4) scenarios.

For children, potential future risks at the Site are from the soil ingestion and groundwater ingestion pathways. For adults, only the groundwater pathway represents a chronic health hazard risk exceeding 1.0. Cumulative carcinogenic risk for adults under future potential conditions is driven by the groundwater pathway. These cumulative carcinogenic risks exceeded 1 x 10^{-6} under both most probable case (1.76 x 10^{-3} cumulative; groundwater only 1.68 x 10^{3}) and realistic worst case (3.16 x 10^{-3} cumulative; groundwater only 3.05 x 10^{-3}) scenarios.

TABLE 1-13

CUMULATIVE RISK FOR
NONCARCINOGENIC CHRONIC HEALTH HAZARDS
UNDER POTENTIAL FUTURE CONDITIONS

Pathway	Children: Most Probable Case	Children: Realistic Worst Case	Adult: Most Probable Case	Adult: Realistic Worst Case
Soil Ingestion	1.78×10^{0}	1.88×10^{0}	2.17×10^{-1}	2.29×10^{-1}
Inhalation	3.37×10^{-2}	4.27×10^{-2}	1.92×10^{-2}	2.44×10^{-2}
Groundwater Ingestion	2.49×10^{1}	3.13×10^{1}	1.20×10^{1}	1.51×10^{1}
Direct Contact	4.62×10^{-2}	2.91×10^{-1}	1.27×10^{-2}	4.82×10^{-2}
TOTAL	2.67×10^{1}	3.35×10^{1}	1.22×10^{1}	1.54×10^{1}

TABLE 1-14

CUMULATIVE RISK FOR
CARCINOGENIC RISK FOR ADULTS
UNDER POTENTIAL FUTURE CONDITIONS

Pathway	Most Probable Case	Realistic Worst Case
Soil Ingestion	6.10×10^{-5}	8.82×10^{-5}
Inhalation	1.50×10^{-5}	1.80×10^{-5}
Groundwater Ingestion	1.68×10^{-3}	3.05×10^{-3}
Direct Contact	2.00×10^{-8}	6.21×10^{-7}
TOTAL	1.76×10^{-3}	3.16×10^{-3}

(CL5178B/2)

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 Introduction

This Section of the FS provides a summary of the goals and objectives which the remedial action alternatives must satisfy. General response actions and technologies that can be employed to meet the remedial goals are then presented and screened.

2.2 Remedial Action Objectives For Soil Remediation

The principle remedial objective for Operable Unit One is to mitigate the potential risks to human health and the environment posed by soil contamination at the site. Remedial objectives for addressing soil contamination at the Site are summarized in Table 2-1. Acceptable soil concentrations were calculated for those contaminants that posed a carcinogenic risk greater than 1.0 x 10^{-6} or a chronic non-carcinogenic health hazard (defined as a hazard ratio greater than 1.0) via the inhalation or incidental soil ingestion pathways based on the exposure scenarios described in the EA. The concentrations given in Table 2-1 were calculated using exposures under realistic worst case conditions. The concentration calculated for arsenic using the incidental soil ingestion pathway is well below average background levels. The cleanup goal for arsenic would therefore be to achieve area background levels of about 6.5 mg/kg.

The unacceptable risks associated with the Auto Ion site have been identified by the Risk Assessment studies to be as follows:

- o Direct contact with contaminated surface soils at the site, either through inhalation or ingestion; and

- o Ingestion of groundwater that has become contaminated by passing through soils below the site.

TABLE 2-1

EXISTING SOIL CONCENTRATIONS AND PROPOSED CLEAN-UP LEVELS

Parameter(1)	Potential Exposure Route	Typical Surface Soil Concentrations Found	Average Regional Background Levels	Tentative Site Background(6)	Risk (2) Level	Theoretical Surface Soil Clean-up Levels (mg/kg)	Determined Soil Clean-up Levels (mg/kg)7
Arsenic	Inhalation of Surface Soils	BDL-80	<1-6.5	BDL-10	1.00 E-06	1.4	6.5
Arsenic	Incidental Surface Soil Ingestion	BDL-80	<1-6.5	BDL-10	1.00 E-06	0.389	6 5
Lead	Incidental Surface Soil Ingestion	5.6-928	<10-20	1.3-30	1.00 E+00	119.0	119
Nickel	Inhalation of Surface Soils	13-1,020	<5-15	BDL-9.7	1.00E-06	83.3	83
Benzo(a)pyrene	Incidental Soil Ingestion	0.140 (3)	NA	BDL	1.00E-06	0.0608 (3)	N/A
Benzo(a)anthracene	Incidental Soil Ingestion	0.460 (3)	NA	BDL	1.00E.06	0.0608 (3)	N/A
Chrysene	Incidental Soil Ingestion	0.370 (3)	NA	BDL	1.00E.06	0.0608 (3)	N/A

(1) Theoretical acceptable soil concentrations were calculated for those indicator chemicals that posed a carcinogenic risk greater than 1.0E-06 or a chronic, non-carcinogenic health hazard (defined as a ratio greater than 1.0) via the inhalation or incidental soil ingestion pathways based on exposure scenarios defined in the EA April 1989. It is assumed that by reducing the concentrations of these parameters to acceptable levels, the concentrations of other indicator chemicals and their associated potential adverse health effects, will also be reduced.

(2) The methodology used to calculate proposed acceptable soil concentrations is based on exposures under Realistic Worst Case conditions given in the Endangerment Assessment. Proposed acceptable concentrations were calculated using an acceptable carcinogenic risk of 1.0-06 and a hazard index of 1.0 and back-calculating to arrive at a soil concentration. (See Appendix F for all calculations and for a description of assumptions used to derive proposed surface soil cleanup levels. Carcinogenic risk calculations for adults were primarily induced by arsenic and subsurface concentrations of PAH's in soil. However, there are numerous discrepancies and uncertainties associated with the potential carcinogenic risks of arsenic. Arsenic is a natural component of the human diet and calculations performed using estimated daily dietary intake concentrations (ATSDR, 1987) produced carcinogenic risks ranging from 1.93 X 10^{-2} (900 ug/day) to 4.29 X 10_{-4} (20 ug/day). Furthermore, carcinogenic risks greater than 1.0 X 10^{-6} were calculated based on ingestion of soil at concentrations equal to average regional background levels (6.5 mg/kg) in soil (calculated risk 3.28 X 10^{-5}). Therefore, the risk calculations performed for arsenic in the endangerment assessment probably greatly over-estimate the actual risks posed by arsenic. Additionally, extremely conservative soil ingestion rates based on EPA's recently issued Interim Final Guidance on Soil Ingestion Rates (Porter, January 27, 1989) were used to derive proposed cleanup levels for potential carcinogens. Based on other ingestion rates found in the scientific literature, EPA's new soil ingestion rates overestimate the level of exposure to adults by an order of magnitude. Therefore, based on adult exposure, proposed soil cleanup levels could be increased by an order of magnitude and still be considered health-protective.

(3) Theoretical acceptable soil concentrations for benzo(a)pyrene, benzo(a)anthracene and chrysene were calculated for subsurface soil concentrations (i.e. 2-20 foot depth interval, because these substances were not detected in the 0-2 foot depth interval) using exposure assumptions for surface soil via the ingestion pathway. This was in accordance with requirements established for the site by EPA Region V. However, the possibility of adults ingesting 100 mg per day of subsurface soil (at a 2 to 20 foot depth interval) for a 70-year lifetime exposure period is unrealistic and unlikely to occur under any current or future conditions.

(4) All data reported in mg/kg.

(5) BDL = Below Detection Limit. NA = Not Applicable.

(6) Tentative Site Background data are from the boring for W-1. During pre-design studies, additional sampling and analysis may be necessary to confirm the validity of this data as actual site background.

(7) Soil clean-up levels will be to regional background concentrations, unless the risk-based factor (1.0 X 10^{-6} cancer risk) or the hazard index (>1.0) result in higher concentrations, in which case, soil clean-up levels will be to those protective levels.

(CL51688/12)

Mitigation of the risks posed by the groundwater contamination at the site will be addressed by Operable Unit Two, which will be presented in a separate FS. The remaining portions of this FS will address the identification, screening, evaluation and recommendation of technologies that are being considered for potential implementation at the Auto Ion site to meet the objective of the Operable Unit One remedial action.

2.3 General Response Actions

General response action scoping for the first Operable Unit at the Site is summarized in Table 2-2. Only institutional actions were eliminated from the scope of applicable responses. This is due to the following factors:

- Site access restrictions have already been emplaced around the site;

- alternative water supplies are not necessary as there are no local water users;

- monitoring will be considered as part of the no-action response.

In addition to the remedial goals discussed above, the following measures identified in the EA should be enacted in order to provide for protection of human health until a remedial action is implemented:

o Access to the Site by visitors and trespassers, especially children, should continue to be restricted.

o The practice of not using groundwater at the Site for drinking water must be continued.

TABLE 2-2

General Response Action Scoping

General Response Actions	Not Applicable	Applicable
No Action		X
Institutional Actions	X	
Collection/Discharge		X
Containment		X
Treatment		X

- o The practice of not using this area of the Kalamazoo River for drinking water should be continued.

- o Fish consumption from the Kalamazoo River should remain restricted.

2.4 Identification and Screening of Technology Types and Process Options

Once the general response actions for the site were established, specific technologies which could be implemented to achieve the remedial objectives were identified and screened. Initially, each technology was individually assessed in terms of its applicability in controlling or treating the substances of concern identified in the EA. The substances of concern were grouped (for purposes of technology screening) as follows:

- volatile organic compounds
- semi-volatile organic compounds
- inorganics

Technologies which were not applicable or feasible, based on site-specific and waste characteristics, were eliminated from further consideration. The technologies that were potentially effective in controlling one or more of these groups in a soil medium were retained for further evaluation.

The technologies further evaluated had to be applicable to mixed waste streams since the information in the RI revealed a mix of hazardous substances at the Site. Furthermore, the technologies must meet, or be capable of meeting, the response objectives set forth in Section 2.2. The technologies were to be applicable to Site conditions and appropriate for implementation.

Technologies that survived this initial screening were then further evaluated in regards to performance, reliability, implementation, and applicability to the Site conditions. As a result of this technology screening process, a list of surviving technologies appropriate for use as a component in a remedial alternative was developed.

2.4.1 Identification and Screening of Technologies

A number of technologies considered potentially applicable for the development of remedial alternatives were subjected to the initial screening. In order to properly scope the Feasibility Study and to maintain a manageable number of alternatives, 10 of these technologies were identified for further use in soil remediation alternatives. The rationale for eliminating certain technologies is described in the following sections.

2.4.1.1 Collection/Discharge Technology Groups

Four technology groups for collecting and discharging contaminants from the site were subjected to the technology screening process. Extraction by pumping wells, on-site discharge and off-site discharge were eliminated from further consideration in developing remedial alternatives. These technologies were eliminated because Operable Unit One is focused on shallow soil remediation and will not involve groundwater. Subsurface drains as a means of collecting groundwater at the site was also eliminated from further consideration. This technology was also eliminated primarily because the shallow depth to groundwater and proximity of the site to the adjacent Kalamazoo River present hydraulic conditions unfavorable for collecting groundwater by trenching.

2.4.1.2 Containment Technology Groups

Five technology groups which can be employed as means of providing containment were subjected to the technology screening process. Capping, surface controls and dust controls were retained for further use in developing remedial alternatives. Vertical barriers and horizontal barriers were eliminated from further consideration. Vertical barriers were eliminated eliminated because Operable Unit One is focused on shallow soil remediation and vertical barriers are a means of controlling groundwater flow..

Horizontal barriers were also eliminated from consideration in the development of remedial alternatives. Horizontal barriers were eliminated due to implementation difficulties associated with the hydraulic conditions at the site. Barriers such as multilayer liners underlying the waste are not likely to be implementable for the following reasons:

- the groundwater table would have to be depressed substantially (10 or more feet) to enable excavation and emplacement of a liner system;

- the liner will have a tendency to be bouyed upwards after the groundwater table has been allowed to return to its natural state.

2.4.1.3 Treatment Technology Groups

The technology screening also considered four groups of treatment technologies. Of the four technology groups falling in the treatment response action category, three were retained for further use in developing remedial alternatives for Operable Unit One. Specifically, chemical, physical, and thermal technology groups were retained for soil treatment. Biological treatment technologies were eliminated from further consideration as potential means of addressing soil contamination at the Site. Several biological-based soil treatment technologies exist but these are, for the most part, applicable to organic substances. Although organics are present in the soil at the Site, the primary concerns are associated with the inorganic contaminants. Additionally, the biological technologies are generally used in conjunction with groundwater pumping/treating. Since groundwater conditions at the Site appear to be complex and variable, and are not fully understood at this time, pumping/treating as an adjunct to biological treatment is not appropriate.

2.4.1.4 Excavation

Two technology groups were screened under the excavation response action category. Excavation, removal and hauling of soils is accomplished using conventional heavy construction equipment. Excavation and removal is applicable to most site conditions and could be used to remove soils at the site. Excavation equipment fall into three general categories: backhoes, cranes and attachments (draglines and clamshells), and dozers and loaders. The equipment and techniques used will be selected based on such considerations as soil conditions, form of the waste, depth of the wastes, and desired excavation rate. Hauling equipment includes scrapers, dozers, loaders, and haul trucks. Like excavation equipment, hauling equipment and methods are selected based on site conditions, but may also be influenced by conditions, such as length of haul, road conditions and restrictions.

Partial excavation was retained for further use in developing remedial alternatives. The total volume of contaminated soil is estimated to be approximately 20,000 cubic yards whereas partial excavation would involve substantially less material. Total excavation was eliminated from further consideration due to the fact that soils have been contaminated to substantial depths below the groundwater table and excavation to these depths in saturated conditions will not be possible. Even with the use of sheeting and shoring coupled with dewatering, excavating to the greater than 80 foot depths required for total excavation will not be possible. This is due primarily to the adjacent river and hydraulic conditions.

2.4.1.5 Disposal Technology Groups

Three technology groups within the land disposal response action category were screened. One technology was identified for on-site disposal of contaminated surface soils/sediments. The applicable disposal technology involves construction of a landfill disposal unit meeting the minimum technology requirements of RCRA Hazardous and Solid Waste Amendments of 1984.

The RCRA-minimum technology cell consists of a multi-layered liner and capping system placed in ascending order:

- o Foundation
- o Three (3) foot clay liner
- o Secondary synthetic liner
- o Leachate detection system
- o Primary synthetic liner
- o Leachate collection system
- o Waste material
- o Synthetic membrane/soil capping system

The strength of the foundation subgrade determines the long-term integrity of the cell. Soils must have sufficient bearing capacity to adequately support the proposed waste volume. The RCRA cell contains a primary and secondary liner system. A leachate detection system consisting of perforated collection pipes connected to header pipes is installed above the secondary synthetic liner. The. primary synthetic liner overlies the leachate detection system. The primary synthetic liner provides the initial and most critical protection against leachate migration. The primary liner is designed to prevent any migration of hazardous material into the underlying leachate detection system separating the primary and secondary liners. The leachate collection system installed above the primary synthetic liner is designed to remove all leachate and runoff generated from the landfill. A six-inch layer of fill material is placed over the leachate collection system to protect the bottom liner system from construction equipment used to place the overlying wastes. The waste material is placed into the cell on top of the above-mentioned layers, and compacted. Following final placement of wastes, a multi-layered capping system normally consisting of synthetic membrane and soil components is constructed to encapsulate the wastes and minimize or eliminate the potential for infiltration. The RCRA landfill minimizes movement of wastes; however, it does not destroy or remove the source of contamination. However, the contaminants are not destroyed when placed in the landfill and continue to pose a threat to human health, welfare and the environment if the unit should fail.

One technology was identified for off-site disposal of contaminated surface soils/sediments. The applicable disposal technology is an existing landfill having a current RCRA permit.

Excavated contaminated soils would be transported to and disposed of at an existing RCRA permitted landfill. Disposal at a RCRA landfill is considered effective and reliable to the extent that contaminants are moved from the site. However, the contaminants are not destroyed when placed in the landfill and continue to pose a threat to human health, welfare and the environment if the unit should fail.

Off-site land disposal was retained for further use in developing remedial alternatives. On-site disposal was eliminated from further consideration because this technology group involves construction of a liner system (see Section 2.1.4.2 for discussion on liner systems). Land farming was eliminated because the principle hazardous constituents at the Site are heavy metals and land farming does not address those constituents. Furthermore, the concentrations of organic hazardous constituents is not sufficient to support biological activity.

2.4.1.6 Evaluation of Technology Groups and Selection of Representative Technologies

The technology groups retained for further consideration are summarized in Table 2-3.

2.4.2 Screening of Technologies

Some of the technology groups retained for further consideration in Section 2.4.1 are associated with more than one specific technology. These technologies were subjected to the screening process in order to eliminate those that pose undue technical difficulties or which do not offer a reasonable level of protection of public health and the environment.

TABLE 2-3

SUMMARY OF TECHNOLOGY GROUPS

General Response Action	Technology Group	Retained	Eliminated
Collection/Discharge	Extraction Wells		X
	Subsurface Drains		X
	On-Site Discharge		X
	Off-Site Discharge		X
Containment	Capping	X	
	Vertical Barriers		X
	Horizontal Barriers		X
	Surface Controls	X	
	Dust Controls	X	
Treatment	Biological		X
	Chemical	X	
	Physical	X	
	Thermal	X	
Excavation	Total		X
	Partial	X	
Disposal	On-Site		X
	Off-Site	X	
	Land Farming		X

2.4.2.1 Capping

Capping technologies considered for the Site included the following:

- clay;
- clay and soil;
- concrete;
- asphalt;
- synthetic;
- multilayer cap.

A single-layer cap is a low permeable layer that can retard the passage of water or gases through the layer. A thickness of two feet of clay is frequently used. Other materials of construction include concrete, asphalt and synthetic membranes. Standard construction practices of six inch layers compacted to 95 percent density can result in permeabilities of 10^{-7} cm/sec or less. However, the cap's theoretical low permeability can be quickly reduced if erosion is not controlled or the cap is subject to repeated wet/dry and freeze/thaw cycles. Consequently, the clay layer is oftentimes covered with a soil layer for protection. The benefits of a clay cap include reduction of infiltration of water and stabilization of the contaminated surface soils. The technology is effective and has good longevity and durability assuming proper design, installation and maintenance. Long-term maintenance of the cap would be required.

A multi-layer cap can be designed to meet the requirements of a RCRA cap. The cap consists of the following: a bedding layer installed on top of the contaminated soil, an impervious layer of clay (2 feet), a second bedding layer and a second impervious layer (20 mil synthetic liner, minimum), a drainage layer (1 foot) and a vegetative cover. Because of multiple layers of impervious material (clay and synthetic liner), the amount of infiltration into the soil compared to the simple clay cap is significantly reduced. The benefits of a multimedia cap includes significant reduction of infiltration of water into the soil, a reduction in generation of groundwater and subsequent migration. This technology is effective and has good longevity and durability assuming proper design, installation, and maintenance. Long-term maintenance of the cover would be required throughout the life of the cap.

Only the multi-layer capping technology survived the screening process. Earthern capping technologies including clay and clay/soil systems were screened out due to uncertainties over long term reliability associated with erosion during flood events in the adjacent Kalamazoo River. Concrete and asphalt capping systems were also eliminated due to long-term reliability considerations. These two capping systems can be subject to severe deterioration from freezing/thawing and the local climate is such that the rigid capping systems would be repeatedly subjected to these conditions.

Synthetic capping systems were also eliminated because of potential problems with erosion of the soil cover and damage to the synthetic material during flood events in the river.

It should be noted that the multi-layer capping technology including synthetic liners, soil/clay layers and vegetative cover would be modified to address the potential for flood related damage. Specifically, this technology will incorporate a layer for scour protection consisting of rip-rap or small boulders.

2.4.2.2 Surface Controls

Four technologies within the surface controls group were subjected to the screening process. Grading is the general term for techniques used to reshape the surface of the site in order to manage surface water infiltration and run-off while controlling erosion. The spreading and compaction steps used in grading are techniques practiced routinely at sanitary landfills. The equipment and methods used in grading are essentially the same for all landfill surfaces, but applications of grading technology will vary by site. Grading is often performed in conjunction with surface sealing practices and revegetation as part of an integrated landfill closure plan.

Surface grading, and sedimentation/erosion fencing were retained for use in developing remedial alternatives. Surface water diversion was eliminated from consideration due to the very flat site topography. Stabilization was also eliminated because it does not address site specific conditions, i.e., slope stabilization does not apply to nearly flat sites. It should be noted that stabilization for scour protection during flood events was incorporated into the multi-layer capping technology (see Section 2.4.2.1).

2.4.2.3 Dust Control Technologies

The following technologies for dust control were considered during the technology screening process:

- water application;
- calcium chloride application;
- wind barrier fencing;
- vegetative cover.

Water application and wind barrier fencing were retained for further use in developing remedial alternatives. Calcium chloride application was eliminated from further consideration because of potential adverse environmental impacts associated with saline runoff into the adjacent river.

Vegetative cover was eliminated from consideration because this technology does not address site conditions. Although a vegetative cover currently exists over portions of the site, a vegetative cover is not implementable during disruptive or intrusive earthmoving activities. Vegetative cover is considered as part of the multi-layer capping technology (see Section 2.4.2.1).

2.4.2.4 Chemical Treatment Technologies

Ten chemical treatment technologies were included in the screening process. Neutralization was retained for use developing in soil remediation alternatives.

Alkali metal dechlorination, catalytic dechlorination, polymerization and chemical reduction were eliminated from further consideration because these technologies do not address the hazardous constituents that are most prevalent at the site. Ozonation, UV-ozonalysis, and UV-photolysis were eliminated from further consideration due to the need for highly specialized equipment, energy intensiveness and effectiveness for only some of the organic substances present at the site.

Chemical reduction can be employed to change the ionic state of some inorganic elements, thereby changing the toxicity and/or mobility of those elements. This technology was eliminated from further consideration due to the fact that the ionic state of the inorganic contaminants present at the Site is not known. Furthermore, of the inorganics found at the Site, only chromium is readily amenable to chemical reduction. Therefore, chemical reduction does not address the Site-specific contaminants.

Hydrolysis was also eliminated from further consideration since such reactions normally require severe operating conditions and are not readily applicable to a soil matrix.

2.4.2.5 Physical Treatment Technologies

Twenty physical treatment technologies were considered during the technology screening process. Of these, solidification and in-situ vitrification were retained for use in developing remedial alternatives. Many of the technologies within this group were eliminated from further consideration because they are not applicable to the soil matrix that comprises Operable Unit One. Technologies that were eliminated for this reason include carbon adsorption, centrifugation, dialysis, electrodialysis, distillation, evaporation, filtration, microwave plasma, ion exchange, reverse osmosis, precipitation/flocculation, and catalysis.

Fixation/solidification processes involve the mixing of the wastes with a chemical reagent to limit the solubility or mobility of the hazardous waste constituents. The contaminants may be chemically bound or encapsulated by the reagent. In most instances, the waste must be tested to find which solidification/stabilization agent is best and most economical. The waste is contacted and mixed with the solidification/stabilization agent chosen. After the mixture has hardened, it can be and disposed. Solidification can either be accomplished in-situ utilizing conventional earth moving equipment or injection systems, or on-site in a batch or continuous processing plant.

A number of new and development technologies are emerging for the solidification/stabilization process. Two technologies being researched for hazardous waste solidification/stabilization include:

- o the chloranan additive;
- o organically modified clays and other proprietary additives.

The following is a description of the Chloranan stabilization process. Contaminated soil or sludge is first screened to remove material which is oversized for the process equipment. The waste is then mixed with Chloranan and cement. Chloranan, a nontoxic chemical, encapsulates and helps to bind the organics contaminates to soil and sludges. The pozzolanic material used is typically Portland cement, fly ash, or kiln dust. The product material is then allowed to cure or harden into a concrete mass. The solidified mass can then be disposed of at an appropriate landfill or redeposited on site.

Chloranan additive and cement can be used to treat hazardous soils contaminated by organic compounds and heavy metals. This solidification technology was developed by Hazcon, Inc. and was demonstrated under the Site program at a former oil reprocessing facility in Douglasvilla, PA. Soils at the site were contaminated with PCBs, oil and grease, heavy metals, and volatile and semi-volatile organics.

Under this EPA-sponsored demonstration, the technology was found to successfully solidify high organic content (25%) waste, and to immobilize lead and zinc. A reduction factor of over 100 (in terms of TCLP leachate concentrations) for lead and zinc resulted during this demonstration. However, the TCLP leaching tests showed that samples of the treated waste containing semi-volatile organics leached these substances in nearly the same concentrations as untreated soil (low ppm range). The demonstration showed good physical properties of the treated waste, and high volume increases (on the order of 100%) for dry matrices such as soils (EPA/540/M5/89/001, March 1989).

Organically modified clays in conjunction with a cement mixture can be used to stabilize/solidify contaminated soil which contains organic wastes as conventional methods of stabilization/solidification sometimes have problems stabilizing/solidifying and preventing leaching of organic wastes. Organically modified clays attempt to solve this problem.

Organically modified clay can be mixed with the contaminated soil or sludge to adsorb and chemically bind organic wastes. Cement is then added and the cement, clay, and contaminated soil mixture is allowed to harden. The organic wastes are now chemically bound to the clay and the clay is enclosed within the cement. The organics held within the clay are now less likely to leach even if the cement/clay matrix disintegrates. The product of the stabilization/solidification is a monolithic cement mass which can be redeposited on-site.

Another example of a proprietary additive-based stabilization technology was the IWT stabilization demonstration, performed under EPA sponsorship, in Hialeah, Florida (EPA/540/M5-89/004, April 1989). In this demonstration, a proprietary additive was used to generate a complex crystalline connective network of inorganic polymers formed primarily of covalent bonds. This additive-based technology results in a two-phased reaction wherein the contaminants are first complexed in a fast reaction, then form macromolecules over a long period of time. The preliminary findings of the Hialeah demonstration showed that this technology produces a solidified mass with good physical properties (except for resistance to freeze/thaw cycles). Untreated soils containing 220-650 mg/kg of PCB, were found to have PCB concentrations in a TCLP extract of <1.0 to 400 ug/L. Treated soils were found to have PCB concentrations of 9.6-82 mg/kg, with TCLP extract concentrations consistently <1.0 ug/L. Initial data regarding immobilization of four metals (Cr, Cn, Pb and Zn) showed some reduction in TCLP leachate concentrations. In one mix, the reduction was approximately 10 fold from 2650 ug/L to 210 ug/L.

A number of other technologies were eliminated because they do not address the site-specific contaminants. Technologies that were eliminated for this reason include air stripping, steam stripping, in-situ adsorption, and solvent extraction. All of these were eliminated because they do not address the primary contaminants at the Site (i.e., inorganics). Freeze crystalization was eliminated from further consideration because it has not yet been commercialized and is still in an experimental stage.

The soil washing process extracts contaminants from soil-sediment matrices using a liquid medium as the washing solution. This process can be used on excavated soils which are fed into a washing unit. The washing fluid may be composed of water, organic solvents, water/chelating agents, water/surfactants, acids, or bases, depending on the contaminant to be removed. Contaminated soil enters the system through a feeder where oversized nonsoil materials and debris that cannot be treated are removed with a coarse screen. The waste passes into a soil scrubber where it is sprayed with washing fluid. Soil particles greater than 2 mm in diameter leave the scrubber and are settled on a drying bed. The remaining soil enters a counter-current chemical extractor where washing fluid is passed counter-current to it, remaining the contaminants. The treated solids are then settled on a drying bed. The remainder of the process is a multi-step treatment for removal of contaminants from the washing fluid prior to its recycling. Soil washing was eliminated from further consideration because it would necessarily be used in conjunction with groundwater pumping and treating. Since groundwater conditions at the Site appear to be complex and variable, and are not fully understood at this time, pumping/treating as a necessary component to soil washing will not be reliable and/or implementable. Therefore, soil flushing was eliminated.

Surface encapsulation was eliminated due to an anticipated lack of reliability due to the location of the Site in a floodplain.

2.4.2.6 Thermal Treatment Technologies

Fourteen thermal treatment technologies were screened for possible use in soil remedial alternatives. Infrared processing systems are designed to destroy hazardous wastes with infrared energy generated from heating elements as the auxiliary heat source. Most types of solid wastes and sludges (including contaminated soils) can be treated with the total system (i.e., including use of the primary and secondary combustion chamber). Wastes are transported on a woven, metal alloy conveyor belt through the furnace for a precise residence time. After the wastes pass under infrared heating elements, ash residue is discharged to a hopper and the off-gases are exhausted to a secondary chamber (fired with oil or gas if required) to ensure complete combustion. Exhaust gases from the secondary chamber are then passed through appropriate air pollution control equipment prior to release through a stack.

Rotary kiln incinerators are inclined, refractory-lined cylinders used primarily for the combustion of organic solids and sludges including contaminated soils. Wastes are injected into the high end of the kiln and passed through the combustion zone as the kiln rotates. Rotation of the combustion chamber creates turbulence and improves the degree of burnout of the solids. Wastes are substantially oxidized to gases and inert ash within this zone. Ash is removed at the bottom end of the kiln while flue gases are passed through a secondary combustion chamber and then through air pollution control units for particulate and acid gas removal. Although organic solids combustion is the primary use of rotary kiln incinerators, liquid and gaseous organic wastes can also be handled by injection into either the feed end of the kiln or the secondary chamber. Wastes having high inorganic salt content (e.g., sodium sulfate) are not recommended for incineration in this manner because of the potential for degradation of the refractory and slagging of the ash. Similarly, the combustion of wastes with high toxic metal content can result in elevated emissions of toxic air pollutants which are difficult to collect with conventional air pollution control equipment.

Infrared incineration was retained as it is a proven means of treating soil and the low gas throughput minimizes production of metal bearing particulate. Rotary kiln incineration is also potentially applicable but the large gas throughput will increase particulate generation and require more elaborate air pollution controls.

2.5 Summary of the Technology Screening Process

The technologies that were retained for use in developing remedial technologies are as follows:

- Multi-layer capping;
- Surface grading;
- Sedimentation/erosion fencing;
- Dust control by water application;
- Dust control by wind fencing;
- Neutralization;
- Solidification;
- In-situ vitrification;
- Infrared incineration;
- Off-site landfill.

3.0 DEVELOPMENT AND SCREENING OF ALTERNATIVES

3.1 Approach to Developing Alternatives

In assembling remedial alternatives for the Auto Ion Site, general response actions and the process options chosen for various technology types were combined to form alternatives. This was accomplished by combining different technology types with different quantities of impacted media and/or different areas of the site. For example, partial excavation was combined with (1) all of the contaminated soils overlying the groundwater table and exhibiting contaminant concentrations in excess of site background, and (2) the highly contaminated soils in the northwestern corner of the site. As required by the National Contingency Plan and EPA guidance, a no-action alternative was included.

A summary of the potential remedial alternatives developed to address the impacted soils at the Auto Ion site is presented in Table 3-1.

3.2 Screening of Alternatives

The primary purpose of alternative screening is to reduce the list of developed alternatives to a manageable number for subsequent detailed analysis. The alternatives are evaluated on the basis of effectiveness, implementability, and cost. Based on this screening process, a list of alternatives will be selected for detailed evaluation.

3.2.1 Screening Criteria

3.2.1.1 Effectiveness Evaluation

Each alternative will be screening in terms of the degree of protectiveness to human health and the environment it will/can provide. Both short- and long-term protectiveness will be considered. Short-term effectiveness refers to the construction and implementation period.

TABLE 3-1. SUMMARY OF SOIL ALTERNATIVES

GENERAL RESPONSE ACTION: TECHNOLOGY TYPE	AREA OR VOLUME	ALTERNATIVE 1 No action	ALTERNATIVE 2 Neutralization Capping	ALTERNATIVE 3 Stabilization Capping	ALTERNATIVE 4 Vadose zone Excavation Disposal	ALTERNATIVE 5 Selected Excavation Disposal	ALTERNATIVE 6 Excavation Disposal	ALTERNATIVE 7 Vadose zone Excavation Stabilization Disposal	ALTERNATIVE 8 Selected Excavation Stabilization Disposal	ALTERNATIVE 9 Excavation Incineration Ash Disposal	ALTERNATIVE 10 Excavation Incineration Ash Disposal	ALTERNATIVE 11 Excavation Incineration Ash Disposal Capping	ALTERNATIVE 12 ISV Capping	ALTERNATIVE 13 ISV Capping
MONITORING AND INSPECTION	Entire site	*												
EXCAVATION	All soil above groundwater				*			*		*	*	*		
	Soil above groundwater that is above cleanup level					*			*					
	All soil above cleanup level						*							
DISPOSAL	Off-Site permitted Landfill				*	*	*	*	*	*	*	*		
MULTI-LAYER CAPPING	Entire site		*	*									*	
	NW corner "hot spot area"											*		*
TREATMENT BY NEUTRALIZATION	All soil above cleanup level		*											
TREATMENT BY STABILIZATION	All soil above cleanup level and g/w			*				*	*					
THERMAL TREATMENT	On-site permitted infared unit									*				
	Off-site permitted incinerator										*	*		
	In-situ vitrification of all soil above groundwater and above cleanup level													*
	In-situ vitrification of all soil above cleanup level												*	
SEDIMENTATION CONTROL	Wind barrier fence		*	*										
	Water application				*	*	*	*	*	*	*	*		

3.2.1.2 Implementability Evaluation

Each alternative will also be screened in terms of implementability, a measure of both the technical and administrative feasibility of constructing, operating and maintaining the alternative. Technical feasibility includes the ability to construct, reliably operate, and meet technology-specific regulations until the operable unit is complete. Operation, maintenance, replacement, and monitoring of technical components after the operable unit is complete are also aspects of technical feasibility. Administrative feasibility will be evaluated in terms of the ability to obtain permits/approvals and the availability of treatment/disposal capacity.

3.2.1.3 Cost Evaluation

The capital and operation/maintenance costs associated with each alternative will be considered in the alternative screening. Cost estimates at this point in the FS will not be of absolute accuracy, as the focus will be to make comparative estimates with relative accuracy to support cost decisions between alternatives. Cost elements common to all alternatives (engineering, construction management, contingencies) will not be estimated at this point in the FS, but will be considered in the detailed analysis (see Section 4).

The cost estimates used in the alternative screening process will be based on several sources of information. Commercial cost estimating guides such as Means Site Work Cost Data, generic unit costs derived from other publications, vendor contacts and actual cost data from similar sites will be used. References for all cost data will be provided.

3.2.2 Results of Alternative Screening

3.2.2.1 Alternative 1 - No Action

This alternative comprises the No Action alternative for soil remediation. The NCP upon which the FS guidelines are based requires evaluating a no action alternative as a means of identifying the problems posed by a site if no remedial work were to be implemented. At the Auto Ion Site, the no action alternative for Operable Unit One would consist of the following limited activities and conditions:

- continued limited access to the Site; and

- concentrations of the substances of concern would remain at their current levels.

Under the no-action alternative, the existing chain-link fence would be inspected periodically to preserve its integrity and warning signs would be posted over the entire length of the fence to inform the public of the hazard associated with the site. Periodic sampling and analysis would be performed to monitor environmental conditions at and around the site.

Effectiveness:

The No Action Alternative does not satisfy any of the remedial objectives for Operable Unit One as set forth in Section 2.2. This alternative does not reduce the mobility, toxicity, volume or concentrations of indicator chemicals in on-site soils to levels which will not cause adverse health affects. Furthermore, this alternative is considered to be the least effective because it allows continued release of contaminants from the site, and it does not reduce or eliminate the probability of direct contact with contaminated soils. This alternative does not permanently destroy or detoxify any of the soil contaminants. It will not improve the existing site environmental conditions and might possibly increase negative impacts over current conditions.

Implementability:

This alternative is readily implementable because existing security and monitoring systems are in place. Nothing is required to implement this alternative other than periodic inspection, maintenance, and monitoring.

Cost:

Virtually no costs are associated with this alternative except for maintenance of existing site security and monitoring systems.

3.2.2.2 Alternative 2 - Neutralization/Capping

This alternative involves neutralizing the site soils using agricultural lime. The lime would be introduced to the soils by mixing with heavy equipment or tilling using farm machinery. The neutralization process would be followed by construction of a multi-layer capping system over the entire surface of the site. Grading and diversion would be necessary being essential to the continued performance and reliability of a cap. Capping in this Alternative would consist of an earthern subbase, geotextile, synthetic membrane, porous drainage layer, rip rap or boulders for flood erosion control, earthern cover and revegetative cover.

Effectiveness:

The ability to effectively neutralize/lime treat the site soils cannot be determined without conducting testing. Capping of soils would effectively prevent direct contact with soils on site. Potentially hazardous and non-hazardous dust generated during construction of the multilayer cap is a possible adverse but short-term effect on public health and the environment. The cover would prevent precipitation infiltration into contaminated soils thus minimizing or eliminating leaching of soluble substances into the groundwater. Therefore, some reduction in mobility of the hazardous substances would be realized. After construction, no impacts from emissions of volatiles and particulates would occur due to the physical barrier created by the capping system. Capping does not permanently destroy or detoxify any of the hazardous substances on site.

Implementability:

Due to the depth of impacted soils, it would be necessary to excavate and mix the soils with lime, then return the treated soils to the excavation(s). The capping process can easily be implemented.

Cost:

Site work, labor and equipment for application of the neutralizing agent constitute the major elements under this alternative. Low costs are associated with capping processes due to the relatively small surface area to be capped.

3.2.2.3 Alternative 3 - Stabilization/Capping

Alternative 3 involves treating soils above the groundwater table and above risk levels by stabilization or fixation. Chemical fixation relies on the reactions of cementation/setting agents such as cement, lime or silicates to form chemical and/or physical bonds with the hazardous constituents, thereby eliminating or minimizing their respective abilities to be transported through (or out of) the medium of concern. The use of Portland cement for solidification purposes can physically incorporate a broad range of waste types. Most wastes however will not be chemically bound and might leach. Cement solidification is most suitable for immobilizing metals. The pH of the cement mixture converts most multivalent cations into insoluble hydroxides or carbonates. However, these substances are insoluble over a small pH range and are subject to solubilization and leaching in the presence of even mildly acidic leaching solutions such as rain. Portland cement alone is also not effective in immobilizing organics.

Portland cement is generally used as a setting agent in silicate-based solification process. This method uses siliceous materials together with lime, cement and gypsum. The silicate material may be fly-ash or other readily available pozzolanic material. A silicate-based process can employ a wide range of materials stabilizing metals, waste oils and solvents. A limitation of this process is that large amounts of water remain in the solid after solidification. This liquid will leach, in open air, until it comes to some equilibrium moisture content with the surrounding soil. This solidified product is likely to require secondary treatment.

Sorbents can be used in order to remove free liquid and to improve waste handling. Although sorbents prevent drainage of free water, they do not necessarily prevent leaching of wastes. The choice of fixation agents is normally waste specific and requires treatability testing.

Under this alternative, the waste soils at the site would be contacted and mixed with the fixation agent(s) chosen and allowed to cure or harden. The fixation process would be followed by construction of a multi-layer capping system over the entire surface of the site. Surface grading would be performed to provide a suitable base for the overlying multi-layer capping system. The capping system would be as described in Alternative 2 above, and would extend over the entire surface area of the site.

Effectiveness:

Chemical fixation processes mechanically bind contaminants within a monolithic matrix exhibiting higher structural integrity than the untreated soil. Therefore, a reduction in the mobility of the hazardous substances would be realized. Stabilization methods limit the solubility or mobility of waste constituents.

Capping of soils effectively prevents direct contact of soils on site by creating a physical barrier. Potentially hazardous and non-hazardous dust generated during construction of the multilayer cap is a possible adverse, but short-term effect on public health and the environment. Dust control measures including water application would minimize or mitigate those impacts. The cover would prevent precipitation infiltration into contaminated soils thus eliminating leaching of soluble substances into the groundwater. After construction, no impacts from emissions of volatiles and particulates would occur due to the physical barrier created by the capping system. Capping does not permanently destroy or detoxify any of the hazardous substances on site. Grading and diversion would be essential to the continued performance and reliability of a cap.

Implementability:

Commercial cement mixing and handling equipment can generally be used for silicate-based solidification. Equipment requirements include chemical storage hoppers, chemical feed equipment, mixing equipment, and waste handling equipment. Construction of the capping system can easily be implemented.

Cost:

Costs for solidification are dependent on reagent costs, since it typically makes up from 40 to 65% of the total cost. The insitu technique is the fastest and most economical. Labor and equipment make up less than 5% of the total treatment cost. Mobile mixing plants require handling of both the treated and the untreated product, increasing the cost even more. Low costs are associated with construction of a capping system due to the small surface area of the site.

3.2.2.4 Alternative 4 - Vadose Zone Excavation/Disposal

This alternative involves excavation of soils containing contaminants above clean-up levels and situated above the groundwater table. These soils would be transferred into trucks and transported to an approved off-site land disposal facility. The excavated site would then be restored by backfilling with clean fill material, grading to promote drainage, and revegetated.

Effectiveness:

Excavation is a highly effective way of permanently removing contaminated soils from the site. Excavation of contaminated soils can disperse dust and volatile organics to the atmosphere, although construction measures can be taken to control and minimize such releases. There is also an increased risk of accident and exposure during off-site transportation. However, over the long run, excavation would prevent direct contact with contaminated soils. The removal of contaminated soils will eliminate the potential for soluble contaminants leaching into the groundwater. Under this alternative, the presence of contaminants at the Auto Ion site are significantly reduced.

Off-site disposal of the excavated soils significantly reduces the presence of contamination at the site. Long-term monitoring for the site would not be required, other than for evaluation of subsequent remedial action. Beneficial results can be achieved in a relatively short time as compared to other alternatives.

Implementability:

This Alternative is considered readily implementable. Excavation would be routine using commercially available equipment and common procedures. The disposal of large volumes of soil may impose scheduling constraints due to limited available transportation capacity to secure landfills. The transportation of hazardous waste and materials is regulated by the Department of Transportation, EPA, States, and local ordinances and codes.

Cost:

Excavation can be cost intensive. Off-site disposal costs are highly variable. The distance to an approved landfill has an impact on costs.

3.2.2.5 Alternative 5 - Selected Vadose Zone Excavation/Disposal

This alternative is similar to Alternative 4, except that in this alternative the excavation would involve those soils contaminated above the levels specified in column 6 of Table 2-1.

- o Areas below the top two feet that contain contaminants above the clean-up levels would also be excavated. The depths to which these areas would be excavated are either to points at which contaminant presence in the soil is at or below clean-up levels or to a point just above the top of the groundwater table, whichever is encountered first (contaminants present below the groundwater table will be addressed under a subsequent Operable Unit).

Effectiveness:

Excavation is a highly effective way of permanently removing contaminated soils from the site. Excavation of contaminated soils can disperse dust and volatile organics to the atmosphere, although construction measures can be taken control and minimize such releases. There is also an increased risk of accident and exposure during off-site transportation. However, over the long run, excavation would prevent direct contact with contaminated soils. The removal of contaminated soils will eliminate the potential for soluble contaminants leaching into the groundwater. Under this alternative, the presence of contaminants at the Auto Ion site are significantly reduced.

Off-site disposal of the excavated soils significantly reduces the presence of contamination at the site. Long term monitoring requirements for the site would be lower for the excavation and off-site disposal option than for any other alternative. Beneficial results can be achieved in a relatively short time as compared to other alternatives.

Implementability:

This alternative is considered readily implementable. Excavation would be routine using commercially available equipment and common procedures. The disposal of large volumes of soil may impose scheduling constraints due to limited available transportation capacity to secure landfills. The transportation of hazardous wastes and materials is regulated by the Department of Transportation, EPA, States, and local ordinances and codes.

Cost:

Excavation can be cost intensive. Off-site disposal costs are highly variable. The distance to an approved landfill has an impact on costs.

3.2.2.6 Soil Alternative 6 - Complete Excavation/Disposal

Alternative 6 is a partial-excavation-based soil remediation alternative. In this case, all soils containing contaminants above clean-up levels (irrespective of the location of the groundwater table) would be removed for off-site land disposal. The excavated site would then be restored by backfilling using clean fill material, grading to promote drainage, and revegetating.

Effectiveness:

Excavation of contaminated soils can disperse dust the volatile organics present in the soils can be released to the atmosphere during excavation. There is an increased risk of accident and exposure during transportation. However, over the long run, excavation would prevent direct contact with soils. The removal of contaminated soils will eliminate the potential for soluble contaminants leaching into the groundwater. Soil contaminants are not permanently destroyed, detoxified, nor reduced in volume under this Alternative.

Off-site disposal allows for the contamination at the site to be essentially eliminated as well as the need for long-term monitoring.

Implementability:

This alternative is not considered readily implementable due to the extreme depths of excavation required. Dewatering and treatment of the contaminated groundwater would be necessary. Excavation is readily implementable using commercially available equipment and procedures. The disposal of a large volume of soil may impose scheduling constraints due to limited available transportation capacity to secure landfills. The transportation of hazardous waste is regulated by the Department of Transportation, EPA, States, and local ordinances and codes.

Cost:

This alternative involves high costs primarily due to the need for dewatering and treatment. Excavation under this alternative would be highly cost intensive due to the need for sheeting or shoring to access the deep soils. Off-site disposal costs are highly variable. The distance to an approved landfill also has an impact on costs.

3.2.2.7 Alternative 7 - Vadose Zone Excavation/Stabilization/Disposal

Alternative 7 has limits of excavation based on the clean-up levels. Soils to be excavated under this Alternative include those containing contaminants above clean-up levels, and located above the groundwater table. Waste handling, and site restoration would be as described in Section 3.2.2.4.

Effectiveness:

Excavation of contaminated soils can disperse dust and the volatile organics present in the soils can be released to the atmosphere during excavation. There is an increased risk of accident and exposure during transportation. However, over the long run, excavation would prevent direct contact with soils. The removal of contaminated soils will eliminate the potential for soluble contaminants leaching into the groundwater.

Chemical fixation processes mechanically bind contaminants within a monolithic block matrix with higher structural integrity than the untreated soil. Therefore a reduction in the mobility of the substances would occur. Stabilization methods limit the solubility or mobility of waste constituents. The use of Portland cement for solidification purposes can physically incorporate a broad range of waste types. Most wastes however will not be chemically bound and might leach. Cement solidification is most suitable for immobilizing metals. The pH of the cement mixture converts most multivalent cations into insoluble hydroxides or carbonates. However, these substances are insoluble over a small pH range and are subject to solubilization and leaching in the presence of even mildly acidic leaching solutions such as rain.

Portland cement alone is also not effective in immobilizing organics. Portland cement is generally used as a setting agent in silicate-based solidification process. This method uses a siliceous material together with lime, cement and gypsum. The silicate material may be fly-ash or other readily available pozzolanic material. A silicate-based process can employ a wide range of materials stabilizing metals, waste oils and solvents. A limitation of this process is that large amounts of water may remain in the solid after solidification. This liquid may leach, in open air, until it comes to some equilibrium moisture content with the surrounding soil. This solidified product is likely to require secondary treatment.

Off-site land disposal allows for the shallow soil contamination at the site to almost totally be eliminated as well as the need for long-term monitoring.

Implementability:

This Alternative is considered implementable. Excavation is easy to implement using commercially available equipment and procedures. Commercial cement mixing and handling equipment can generally be used for silicate-based solidification. Equipment requirements include chemical storage hoppers, chemical feed equipment, mixing equipment, and waste handling equipment. The disposal of a large volume of soil may impose scheduling constraints due to limited available transportation capacity to secure landfills. The transportation of hazardous waste is regulated by the Department of Transportation, EPA, States, and local ordinances and codes.

Cost:

This Alternative involves moderate to high costs. Excavation under this Alternative would not be costly. Costs for solidification are dependent on reagent costs, since it typically makes up from 40 to 65% of the total cost. Labor and equipment make up less than 5% of the total treatment cost. Mobile mixing plants require handling of both treated and untreated product, increasing the cost. Off-site disposal costs are highly variable. The distance to an approved landfill also has an impact on costs.

3.2.2.8 Alternative 8 - Selected Vadose Zone Excavation/ Stabilization/Disposal

This Alternative is similar to Alternative 7, except that in this Alternative, the limits of excavation would involve those soils contaminated above the levels specified in Table 2-1, column 6.

- o Selected underlying areas that contain contaminants above the clean-up levels would also be excavated. The depths to which these areas would be excavated are either the point at which contaminant presence in the soil is at or below clean-up levels or to the top of the groundwater table, whichever is encountered first (contaminants present below the groundwater table will be addressed under a subsequent Operable Unit).

Effectiveness:

Excavation of contaminated soils can disperse dust and the volatile organics present in the soils can be released to the atmosphere during excavation. There is an increased risk of accident and exposure during transportation. However, over the long run, excavation would prevent direct contact with soils. The removal of contaminated soils will eliminate the potential for soluble contaminants leaching into the groundwater.

Chemical fixation processes mechanically bind contaminants within a monolithic block matrix with higher structural integrity than the untreated soil. Therefore a reduction in the mobility of the substances would occur. Stabilization methods limit the solubility or mobility of waste constituents. The use of Portland cement for solidification purposes can physically incorporate a broad range of waste types. Most wastes however will not be chemically bound and might leach. Cement solidification is most suitable for immobilizing metals. The pH of the cement mixture converts most multivalent cations into insoluble hydroxides or carbonates. However, these substances are insoluble over a small pH range and are subject to solubilization and leaching in the presence of even mildly acidic leaching solutions such as rain.

Portland cement alone is also not effective in immobilizing organics. Portland cement is generally used as a setting agent in silicate-based solidification process. This method uses a siliceous material together with lime, cement and gypsum. The silicate material may be fly-ash or other readily available pozzolanic material. A silicate-based process can employ a wide range of materials stabilizing metals, waste oils and solvents. A limitation of this process is that large amounts of water may remain in the solid after solidification. This liquid may leach, in open air, until it comes to some equilibrium moisture content with the surrounding soil. This solidified product is likely to require secondary treatment.

Off-site land disposal allows for the shallow soil contamination at the site to almost totally be eliminated as well as the need for long-term monitoring.

Implementability:

This Alternative is considered implementable. Excavation is easy to implement using commercially available equipment and procedures. Commercial cement mixing and handling equipment can generally be used for silicate-based solidification. Equipment requirements include chemical storage hoppers, chemical feed equipment, mixing equipment, and waste handling equipment. The disposal of a large volume of soil may impose scheduling constraints due to limited available transportation capacity to secure landfills. The transportation of hazardous waste is regulated by the Department of Transportation, EPA, States, and local ordinances and codes.

Cost:

This Alternative involves moderate to high costs. Excavation under this Alternative would not be costly. Costs for solidification are dependent on reagent costs, since it typically makes up from 40 to 65% of the total cost. Labor and equipment make up less than 5% of the total treatment cost. Mobile mixing plants require handling of both treated and untreated product, increasing the cost. Off-site disposal costs are highly variable. The distance to an approved landfill also has an impact on costs.

3.2.2.9 Alternative 9 - Excavation/Incineration/Disposal

This alternative involves partial excavation of contaminated soils above the groundwater table, on-site incineration in an infrared thermal treatment unit, and off-site land disposal of the resulting ash. The site would then be restored by backfilling using clean fill material, grading to promote drainage, and revegetating.

Effectiveness:

Excavation of contaminated soils can disperse dust and the volatile organics present in the soils can be released to the atmosphere during excavation. There is an increased risk of accident and exposure during transportation of the resulting ash to the selected disposal facility.

However, over the long run, excavation and thermal treatment would prevent direct contact with soils. The removal of contaminated soils will eliminate the potential for soluble contaminants leaching into the groundwater.

Incineration reduces the hazardous organic substances to less harmful or innocuous constituents, such as carbon dioxide and water. Incineration has little or no effects on metals. Often, metals are oxidized and are separated from the organic compounds to which they may be attached. This Alternative does effectively reduce the toxicity and volume of organic substances in the site soils. However, this process does not affect the toxicity or the volume of the metals in the soils, and may even increase their mobility. All transportable on-site incinerators must apply for and receive an appropriate waste treatment facility operating permit from MDNR. If emission controls are not operating properly at the permitted efficiency, hazardous substances may be released into the atmosphere. In the long run, incineration prevents direct contact with and ingestion of contaminated soils.

The potential for leaching of soluble contaminants into the groundwater is eliminated. The effectiveness of metal stabilization by ash fixation in a non-leachate form has not been determined. There are no environmental impacts from emissions and dispersion of volatile organics and particulates after construction or from erosion of soils by precipitation or flooding.

Off-site disposal of the ash will allow for the shallow soil contamination at the site to almost totally be eliminated as well as the need for long-term monitoring. Beneficial results can be achieved in a relatively short time. Long term impacts include possible groundwater contamination at the landfill in the event its liner or leachate collection systems fail.

Implementability:

Although excavation is easy to implement, this Alternative can not be implemented due to the lack of space for an on-site incinerator. Wastewaters from scrubber may require disposal at a municipal wastewater treatment facility. Operation and maintenance of the system will require a technically trained staff. Pilot testing must be conducted to determine site specific effectiveness. Safety concern results from high temperatures at which thermal destruction process operates as well as typical construction risks. The disposal of a large volume of ash might be delayed due to limited available transportation capacity to secure landfills. The transportation of hazardous waste is regulated by the Department of Transportation, EPA, States, and local ordinances and codes.

Cost:

On-site thermal treatment can be highly cost intensive. Off-site disposal costs for the resulting ash are high and frequently variable. The distance to a RCRA approved landfill also has a significant impact on costs.

3.2.2.10 Alternative 10 - Excavation/Incineration/Disposal

This Alternative is essentially the same as Alternative 9, with the exception that the thermal treatment would be performed at an off-site permitted facility. Under this alternative, the thermal treatment facility would not necessarily be of the infrared-type. Off-site disposal of the resulting ash and site restoration would be as described in section 3.2.2.4.

Effectiveness:

Excavation of contaminated soils can disperse dust and the volatile organics present in the soils can be released to the atmosphere during excavation. There is an increased risk of accident and exposure during transportation. However, over the long run, excavation would prevent direct contact with soils. The removal of contaminated soils will eliminate the potential for soluble contaminants leaching into the groundwater.

Incineration reduces the organic hazardous substances to less harmful or innocuous constituents, such as carbon dioxide and water. Incineration has little or no effects on metals. Often, the metals are oxidized and are separated from the organic compounds to which they may be attached. This process does not affect the toxicity or the volume of the metals in the soils. It may even increase their mobility. Off-site incinerators have limited capacity, so remediation might be delayed pending acceptance of the waste. If emission controls are not operating property at the permitted efficiency, hazardous compounds may be released into the atmosphere. In the long run, incineration prevents direct contact with and ingestion of contaminated soils.

The potential for leaching of soluble contaminants into the groundwater is eliminated. The effectiveness of metal stabilization by ash fixation in a non-leachate form has not been determined. There are no environmental impacts from emissions and dispersion of volatile organics and particulates after construction or from erosion of soils by precipitation or flooding.

Off-site thermal treatment and land disposal allows for the shallow soil contamination at the site to almost totally be eliminated as well as the need for long-term monitoring. Beneficial results can be achieved in a relatively short time.

Implementability:

Excavation is easy to implement. The off-site treatment and disposal of a large volume of soil/ash might be delayed due to limited available capacity of permitted incinerators. Additionally, not all fixed incineration facilities are capable of handling bulk solids and this could adversely impact the implementability of this Alternative. The transportation of hazardous waste is regulated by the Department of Transportation, EPA, States, and local ordinances and codes.

Cost:

Excavation can be cost intensive. Costs for implementation of thermal destruction can be very high. Off-site thermal treatment costs are highly variable. The distance to an approved thermal treatment facility and landfill also has an impact on costs.

3.2.2.11 Alternative 11 - Excavation/Incineration/Capping

This Alternative is essentially the same as Alternative 10 with the addition of a multi-layer capping system over those portions of the site where the remaining soils (below the groundwater table) contain contaminants above clean-up levels. Construction of the multi-layer capping system would be as described in section 3.2.2.

Effectiveness:

Excavation of contaminated soils can disperse dust and the volatile organics present in the soils can be released to the atmosphere during excavation. There is an increased risk of accident and exposure during transportation of the resulting ash to the selected disposal facility. However, over the long run, excavation and thermal treatment would prevent direct contact with soils. The removal of contaminated soils will eliminate the potential for soluble contaminants leaching into the groundwater.

Incineration reduces the organic pollutants to less harmful or innocuous constituents, such as carbon dioxide and water. Incineration has little or no effects on metals. Often, the metals are oxidized and are separated from the organic compounds to which they may be attached. This process does not affect the toxicity or the volume of the metals in the soils. It may even increase their mobility. Off-site incinerators have limited capacity, so remediation might be delayed six months to two years. If emission controls are not operating property at the permitted efficiency, hazardous compounds may be released into the atmosphere. In the long run, incineration prevents direct contact with and ingestion of contaminated soils.

The potential for leaching of soluble contaminants into the groundwater is eliminated. The effectiveness of metal stabilization by ash fixation in a non-leachate form has not been determined. There are no environmental impacts from emissions and dispersion of volatile organics and particulates after construction or from erosion of soils by precipitation or flooding.

Off-site disposal allows for the shallow soil contamination at the site to almost totally be eliminated as well as the need for long-term monitoring. Beneficial results can be achieved in a relatively short time. Long term impacts include possible groundwater contamination at the ash landfill in the event of failure of the liner or leachate collection systems.

Capping of soils effectively prevents direct contact of soils on site. Potentially hazardous and non-hazardous dust generated during construction of the multilayer cap is an adverse but short-term effect on public health and the environment. The cover would prevent precipitation infiltration into contaminated soils thus eliminating leaching of soluble contaminants into the groundwater. After construction, no impacts from emissions and dispersion of volatiles and particulates would occur due to the physical barrier created by the cap. There is no impact from erosion of soils by precipitation and flooding. Capping alone does not permanently destroy or detoxify any of the contaminants on site. Grading and diversion would be necessary being essential to the continued performance and reliability of a cap.

Implementability:

This Alternative is considered implementable. The excavation and transport can be accomplished using common equipment. Permitted, off-site thermal treatment facilities are located within reasonable distances of the Site.

The off-site treatment and disposal of a large volume of soil/ash might be delayed due to limited available capacity in secure landfills. The transportation of hazardous waste is regulated by the Department of Transportation, EPA, States, and local ordinances and codes. The capping process can easily be implemented.

Cost:

Costs for implementation of thermal destruction can be quite high. Excavation can be cost intensive.

Off-site disposal costs are high and frequently result in the exclusion of total disposal. The distance to a RCRA approved landfill also has an impact on costs. Overall, very high costs are associated with this alternative.

3.2.2.12 Alternative 12 - ISV/Capping

Alternative 12 is the first of two remedial alternatives that are based upon the in-situ vitrification (ISV) technology. Under this Alternative, all soils posing a risk greater than $1.0x10^{-6}$ (irrespective of the location of the groundwater table), would be subjected to thermal treatment by in-situ vitrification. Due to the size of the site, ISV treatment would not be performed in one step, but would involve sequential treatment of numerous segments of the Site. Off-gases driven from the soil including water vapor, volatile organics and semi-volatile organics would be collected in a hood overlying the area undergoing treatment. The collected off-gases would then be passed to a vapor phase treatment system. After completion of the ISV treatment, the glass-like monolithic solids would then be covered with an earthern subbase. The site would then be capped using a multi-layer capping system as described in Section 3.3.2.

Effectiveness:

In-situ vitrification is a thermal treatment process that converts contaminated soil into a chemically inert, stable glass and crystalline product. ISV offers essentially complete destruction/removal of hazardous organics. Hazardous inorganics are effectively immobilized in the residual glass product.

During the ISV process, the soil melts from the surface to the desired depth, producing a high-quality residual that is capable of safe, long term environmental exposure. Capping of soils effectively prevents direct contact of soils on site. The cover would prevent precipitation infiltration into contaminated soils thus eliminating leaching of soluble contaminants into the groundwater. After construction no impacts from emissions and dispersion of volatiles and particulates would be expected. There is no impact from erosion of soils by precipitation and flooding. Capping alone does not permanently destroy or detoxify any of the contaminants on site. Grading and diversion would be necessary being essential to the continued performance and reliability of a cap.

Implementability:

Implementing this Alternative would be essentially impossible due to the close proximity of a basement and foundations in the adjacent property. There are also utilities buried on the site. The high energy demand necessary for this process, as well as the need for sophisticated equipment and specially trained personnel, greatly limit the use of such a process. Construction of the capping system can easily be implemented.

Cost:

This process would be very cost intensive for such a low vertical limit of contamination and high soil permeabilities. Estimates of total application costs range from $150 to $350 per ton of vitrified mass. Low costs are associated with construction of the capping system.

3.2.2.13 Alternative 13 - ISV/Capping

Alternative 13 is similar to Alternative 12 except in the vertical limit of the soil to be treated by ISV, and in the extent of the multi-layer capping system. Under this alternative, all soils situated above the groundwater table and exhibiting contaminant concentrations above site background levels would be subjected to ISV treatment. After completion of the ISV treatment, all portions of the Site where the soils contain contaminants above clean-up levels would be covered with a multi-layer system.

Effectiveness:

During the ISV process, the soil melts from the surface to the desired depth, producing a high quality residual that is capable of safe, long-term environmental exposure.

In-situ vitrification is a thermal treatment process that converts contaminated soil into a chemically inert, stable glass and crystalline product. ISV offers essentially complete destruction/removal of hazardous organics. Hazardous inorganics are effectively immobilized in the residual glass product. Capping of soils effectively prevents direct contact of soils on site. Potentially hazardous and non-hazardous dust generated during construction of the multilayer cap is an adverse but short-term effect on public health and the environment. The cover would prevent precipitation infiltration into contaminated soils thus eliminating leaching of soluble contaminants into the groundwater. After construction no impacts from emissions and dispersion of volatiles and particulates would be expected. There is no impact from erosion of soils by precipitation and flooding. Capping alone does not permanently destroy or detoxify any of the contaminants on site. Grading and diversion would be necessary being essential to the continued performance and reliability of a cap.

Implementability

Implementing this Alternative would be essentially impossible due to the close proximity of a basement and foundations on the adjacent property. There are also utilities buried on the site. The high energy demand necessary for this process, as well as the need for sophisticated equipment and specially trained personnel, greatly limit the use of such a process. Construction of the capping systems can easily be implemented.

Cost:

Estimates of total application costs range from $150 to $350 per ton of vitrified mass. This process would be very cost intensive for such a low vertical limit of contamination and for soil permeabilities as high. Low costs are associated with construction of the capping system.

3.3 Summary and Selection of Alternatives for Detailed Analysis

The following Alternatives were retained for detailed analysis:

Alternative 1 - No Action
Alternative 3 - Stabilization/Capping
Alternative 4 - Vadose Zone Excavation/Disposal
Alternative 5 - Selected Vadose Zone Excavation/Disposal
Alternative 7 - Vadose Zone Excavation/Stabilization/Disposal
Alternative 8 - Selected Vadose Zone Excavation/Stabilization/Disposal

Alternative 1, the No Action Alternative only serves as a baseline from which to examine the impacts and costs of not undertaking active remediation. The No Action Alternative was retained for detailed analysis as required by the NCP. This Alternative would leave the Auto Ion site in the condition it is already in. The present risks and hazards will continue to exist and may be exacerbated.

Alternative 3 involving stabilizing soils above the risk level and capping the entire site area will be retained due to its favorable implementation and effectiveness of stabilization in reducing the mobility of contaminants. Under this Alternative, heavy metals present in the waste will remain.

Alternatives 4, 5, 7 and 8 involve excavation of vadose zone site soils for off-site disposal. Alternatives 5 and 8 provide for more selective excavation/disposal such that only vadose zone soils identified as having contaminant levels above clean-up levels will be removed. In both cases, the removal of the soils along with the backfilling of the excavated areas with clean fill provide a significant reduction in the risks posed by the site. Alternatives 7 and 8 include treatment of the excavated wastes prior to off-site land disposal. These Alternatives were retained because it is not currently clear whether wastes subject to the land disposal restrictions are present on-site.

The following Alternatives were eliminated during the screening process:

Alternative 2 - Neutralization/Capping
Alternative 6 - Complete Excavation/Disposal
Alternative 9 - Excavation/Incineration/Disposal
Alternative 10 - Excavation/Incineration/Disposal
Alternative 11 - Excavation/Incineration/Capping
Alternative 12 - ISV/Capping
Alternative 13 - ISV/Capping

Alternative 2 was eliminated on the basis of problems in effectiveness and implementation. Not enough is known of the soils to determine whether neutralization is appropriate or would be effective. Implementing this Alternative for the site would be difficult due to the depth of impacted soils.

Under Alternative 6, the excavation limits are below groundwater making this Alternative very difficult (if not impossible) to implement. Costs would be very high under this Alternative. Any concerns regarding groundwater will be addressed as part of Operable Unit Two.

Alternative 9 involving an on-site incinerator was eliminated for implementation and cost reasons. There is not enough space at the site to construct an on-site unit. The high cost of on-site incineration was also factored into the decision to drop Alternative 9 from further consideration.

Alternatives 10 and 11 were eliminated because of the extremely high cost of incineration, as well as little effectiveness in reducing the toxicity or migration potential of inorganics.

Alternatives 12 and 13 involving insitu vitrification were eliminated because of insurmountable implementation problems, as well as costs. The location of the area to be vitrified is very close to a building on the adjacent property making this process essentially impossible to implement without structural damage to the foundation and building. This technology cannot be used where significant volatiles or buried metals (i.e., pipes) are present.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

The remedial alternatives that survived the screening in Section 3, including No Action, will be subjected to detailed analysis in this section. Technical, public health, environmental and economic criteria and factors will be evaluated.

4.1 Approach and Evaluation Criteria

The US EPA has established nine criteria to be used in the detailed analysis of alternatives. Those criteria address requirements set forth in CERCLA Section 121(b)(1) which outlines general requirements for remedial actions. This section of CERCLA establishes the SARA preference for permanent remedies and for treatment technologies that reduce the mobility, toxicity and/or volume of hazardous substances. Further, Section 121(b)(1) directs that the long term effectiveness of alternatives be evaluated and that (at a minimum) the following be considered in assessing alternatives:

- Long-term uncertainties associated with land disposal;
- Goals, objectives and requirements of the Solid Waste Disposal Act;
- Persistence, toxicity, mobility and propensity to bioaccumulate of hazardous substances and their constituents;
- Short and long-term potential for adverse health effects from human exposure;
- Long-term maintenance costs;
- Potential for future remedial action costs if the alternative was to fail; and
- Potential threat to human health and the environment associated with excavation, transportation and redisposal, or containment.

The criteria used in the detailed analysis presented in this section are:

- o Reduction of mobility, toxicity, and volume (MTV);
- o Short-term effectiveness;
- o Long-term effectiveness and permanence;
- o Implementability;
- o Overall protection of human health and the environment;
- o Compliance with ARARs;
- o Cost.

Brief discussions on each of these criteria are presented below. Two of the evaluation criteria established by EPA were not considered in this Feasbility Study for Operable Unit One. These criteria are:

- State acceptance;
- Community Acceptance.

These criteria will be evaluated by EPA after review and approval of this FS, and prior to selection of a preferred alternative.

4.1.1 Reduction of Mobility, Toxicity, or Volume

The degree to which alternatives employ treatment that reduces toxicity, mobility, or volume will be assessed. Section 121 of the Superfund Amendments and Reauthorization Act of 1986 (SARA, Public Law 99-499) sets forth a statutory preference for remedial actions in which treatment, "... will permanently and significantly reduce the volume, toxicity or mobility of the hazardous substances, pollutants and contaminants," over remedial actions not involving such treatment. The off-site transport and disposal of untreated hazardous substances or contaminated materials is considered under SARA, to be the least favored remedial action, where practical treatmnet technologies are available. According to USEPA OSWER Directive 9355.3-01, factors which may facilitate MTV reduction include:

- The unit treatment processes employed by the remedy and the materials they will treat.

- The amount of hazardous materials that will be destroyed or treated.

- The degree of expected reduction in toxicity, mobility, or volume.

- The degree to which the treatment is irreversible.

- The residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents.

4.1.2 Short-Term Effectiveness

The short-term effectiveness of each alternative will be assessed considering appropriate factors among the following:

- Time until the remedial objectives are achieved.

- Protection of the community during implementation.

- Protection of on-site workers during implementation.

- Environmental impacts.

4.1.3 Long-Term Effectiveness and Permanence

Each alternative will also be assessed for the long-term effectiveness and permanence it afford along with the degree of certainty that the remedy will prove successful. The component factors which are considered include:

- Magnitude of residual risks in terms of amounts and concentrations of waste remaining following implementation of a remedial action, considering the persistence, toxicity, mobility, and propensity to bioaccumulate of such hazardous substances and their constituents.

- Type and degree of long-term management required, including monitoring and operation and maintenance.

- Potential for exposure of human and environmental receptors to remaining waste considering the potential threat to human health and environment associated with excavation, transportation, redisposal, or containment.

- Long-term reliability of the engineering and administrative controls, including uncertainties associated with land disposal of untreated wastes and residuals.

- Potential need for replacement of the remedy.

4.1.4 Implementability

The OSWER Directive also specifies that the ease or difficulty of implementing an alternative be assessed by considering the following types of factors:

- Degree of difficulty associate with constructing the technology.

- Expected operational reliability of the component technologies employed in a remedial alternative.

- Need to coordinate with and obtain necessary approvals and permits from governmental offices and agencies.

- o Availability of necessary equipment and specialists.

- o Available capacity and location of needed treatment, storage, and disposal services.

4.1.5 Overall Protection of Human Health and the Environment

Following the analysis of remedial options against individual evaluation criteria, the alternatives will be assessed from the standpoint of whether they provide adequate protection of human health and the environment considering the multiple criteria.

4.1.6 Compliance with ARARs

Alternatives will be analyzed as to whether they attain legally applicable or relevant and appropriate requirements (ARARs) of other Federal State environmental and public health laws, including as appropriate:

- o Contaminant-specific ARARs (e.g., MCLs, NAAQs, etc.).

- o Location-specific ARARs (e.g., restrictions on actions at historic preservation sites, etc.).

- o Action-specific ARARs (e.g., RCRA requirements for incineration and closure, etc.).

Probable ARARs for Operable Unit One are summarized in Table 4-1.

Since Operable Unit One is focused on soil contamination at the site, draft guidance issued by WND/MDNR (May 1988) pursuant to Michigan Act 307 which sets forth procedures for establishing soil clean-up limits was considered for those alternatives involving physical removal of waste. In essence, the WND/MDNR guidance requires soil remediation so that the concentrations of the contaminants of concern are non-detectable, or in the case of naturally occurring substances, to background levels.

TABLE 4-1

PROBABLE ARARs FOR OPERABLE UNIT ONE

REGULATION OR LAW	REGULATORY OR STATUTORY REFERENCE	APPLICABILITY/REQUIREMENTS	ALTERNATIVE APPLICABILITY 1	3	4	5	7	8
LOCATION SPECIFIC ARARs								
RCRA Facility Location Standards	40 CFR 264.18(a)	Seismic standard applies to placement of waste in the vicinity of a fault displaced in Holocene time.		X				
	40 CFR 264.18(b)	Floodplain standard limits placement of waste in a 100 year floodplain.		X				
Inland Lakes and Streams Act	Michigan Act 346	Establishes guidelines for the construction, enlargement, removal, or placement of a structure on bottom land (floodplain). Permit application to MDNR (and USACOE) required for filling in a floodplain area.		X				
CHEMICAL-SPECIFIC ARARs								
RCRA Land Disposal Restrictions	40 CFR 268	Sets forth prohibitions and restrictions on land disposal, including treatment standards for certain wastes (see Note 1).		X	X	X	X	X
Clean Air Act - National Ambient Air Quality Standard	40 CFR 50.6	Specifies 24-hour standard of 150 ug/m^3 for particulate matter with an aerodynamic diameter equal to or less than 10 microns (PM_{10}).		X	X	X	X	X
Michigan Act 348	Rule 901	Requires that emissions for treatment processes not have injurious effects on human health or safety.		X			X	X

TABLE 4-1
(Continued)

PROBABLE ARARs FOR OPERABLE UNIT ONE

REGULATION OR LAW	REGULATORY OR STATUTORY REFERENCE	APPLICABILITY/REQUIREMENTS	ALTERNATIVE APPLICABILITY 1	3	4	5	7	8
ACTION SPECIFIC ARARs								
RCRA Landfill Cover System	40 CFR 264.310	Sets forth design, operation and maintenance requirements for landfill capping systems.		X				
RCRA Closure of Hazardous Waste Facilities	40 CFR 264.116	Requires survey plat filed with local authority which states the owner's obligation to restrict disturbance of the hazardous waste disposal unit.		X				
RCRA Post Closure Care	40 CFR 264.117	Requires post closure care for the hazardous waste disposal unit for a period of 30 years following closure. Section 264.117(b) requires continuation of access restrictions during the post-closure period.		X				
RCRA Closure Plan	40 CFR 264.112	Sets forth requirements for a written closure plan to be submitted and approved by the Regional Administrator as part of the permit issuance procedures.		X				
RCRA Closure Performance Standard	40 CFR 264.111	Sets forth closure performance standard for controlling, minimizing or eliminating post-closure releases. Also requires closure to be performed in a manner that minimizes further maintenance.		X				

(CL5204B/4)

TABLE 4-1
(Continued)

PROBABLE ARARs FOR OPERABLE UNIT ONE

REGULATION OR LAW	REGULATORY OR STATUTORY REFERENCE	APPLICABILITY/REQUIREMENTS	ALTERNATIVE APPLICABILITY 1	3	4	5	7	8
RCRA Facility Permitting	40 CFR 270	Establishes requirements for RCRA Part A and Part B permit applications, sets forth permit conditions applicable to all permits, establishes procedures for permit modification.		X				
RCRA Generator Standards	40 CFR 262 and Michigan Act 64, Part 2	Sets forth standards applicable to generators of hazardous waste including manifesting, pre-transport packaging/labelling/marking and accumulation, and requirements for recordkeeping and reporting.		X	X	X	X	X
RCRA Transporter Standards	40 CFR 263 and Michigan Act 64, Part 4	Sets forth requirements for transporters of hazardous waste including compliance with the manifest system, recordkeeping and clean-up of discharges during transport.			X	X	X	X
RCRA Design Standards For Landfills	40 CFR 264, Subpart N	Sets forth design and operating requirements for hazardous waste landfills including liner system construction, monitoring, inspection, surveying and recordkeeping.		X				

TABLE 4-1
(Continued)

PROBABLE ARARs FOR OPERABLE UNIT ONE

REGULATION OR LAW	REGULATORY OR STATUTORY REFERENCE	APPLICABILITY/REQUIREMENTS	ALTERNATIVE APPLICABILITY 1	3	4	5	7	8
DOT Rules For Transport of Hazardous Materials	49 CFR 107 and 171.1-5	Specifies procedures for packaging, labelling, manifesting and transporting hazardous materials.			X	X	X	X
OSHA - General Industry Standards	29 CFR 1910.120	Specifies occupational safety and health standards for hazardous waste activities under CERCLA. Includes requirements for safety planning, site control, training, medical monitoring, use of protective equipment and air monitoring.	X	X	X	X	X	X
OSHA - Safety and Health Standards	29 CFR 1926	This regulation specifies the 8-hour time weighted average concentration for various substances, including arsenic, lead and nickel.	X	X	X	X	X	X
OSHA - Recordkeeping and Reporting	29 CFR 1904	Sets forth recordkeeping and reporting for employers.	X	X	X	X	X	X
Michigan Hazardous Waste Management Act - Construction Permits	Act 64, Rule 504	Specifies general information required required from applicants for construction permits seeking to construct new hazardous waste disposal units.		X				

TABLE 4-1
(Continued)

PROBABLE ARARs FOR OPERABLE UNIT ONE

REGULATION OR LAW	REGULATORY OR STATUTORY REFERENCE	APPLICABILITY/REQUIREMENTS	ALTERNATIVE APPLICABILITY 1	3	4	5	7	8
	Act 64, Rule 505	Specifies technical information required from construction permit applicants desiring to construct liner systems for landfills.		X				
Soil Erosion and Sedimentation Control	Michigan Act 347, Rule 1704	Requires a soil erosion and sedimentation plan for any earth changes of one acre or more. Also requires implementation of erosion and sedimentation control measure.		X	X	X	X	X

NOTE 1: Since it is currently unclear whether wastes subject to the land disposal restrictions are present in the wastes to be addressed under Operable Unit One, the land disposal restrictions may or may not be ARARs.

For those Alternatives involving off-site land disposal of excavated materials, the land disposal restrictions (40 CFR 268) may be applicable or relevant and appropriate requirements. It should be noted, however, that it is currently uncertain whether the wastes to be excavated under Alternatives 3, 4, 5, 7 and 8 contain wastes subject to the land disposal restrictions. Therefore, for the purposes of the detailed analysis, the land disposal restrictions will be included as potential ARARs. Additionally, the evaluation of an Alternative's compliance with ARARs will include a discussion of the potential applicability of 40 CFR 268 as an ARAR.

4.1.7 Cost

The cost factors that will be assessed during the detailed alternatives analysis include the following:

- o Capital costs.
- o Operation and maintenance costs.
- o Net present value of capital and operation and maintenance costs.
- o Potential future remedial action costs.

4.2 Alternative 1 - No Action

4.2.1 Description

At the Auto Ion Site, the No Action Alternative for Operable Unit One would consist of the following limited activities and conditions:

- o Continued limited access to the Site; and
- o Concentrations of the substances of concern would remain at their current levels.

Under the no action alternative, the existing chain-link fence would be inspected quarterly to preserve its integrity. Warning signs would be posted over the entire length of the fence to inform the public of the hazards associated with the site. Repairs would be made to the security system and warning signs on an as-needed basis. Quarterly sampling and analyses would be performed to monitor environmental conditions at and around the site. This would be accomplished by use of the existing network of groundwater monitoring wells. For purposes of this evaluation, it is assumed that groundwater samples will be analyzed for volatile organics and plating indicator substances (Ar, Cr, Cu, Pb, Ni, Zn). The site inspector will be a professional engineer who will also check for differential settlement, soil erosion and the maintenance of the vegetative cover. The site inspector will quarterly submit a report to EPA documenting and summarizing the conditions at the site.

4.2.2 Reduction of MTV

This alternative does not address any of the principal threats posed by the site. None of the impacted soil is destroyed or treated. Due to the fact that no remedial action is undertaken, there will be no reduction in the toxicity, mobility, or volume of contaminants. Under this alternative, all contaminated soils would remain unaffected. The residual risks posed by implementing this alternative would be those summarized in Section 2.2.

4.2.3 Short Term Effectiveness

The risks posed to the community are presented in Section 2.2. This would not address those risks nor would it be readily controlled. No short term risks would be associated during implementation of this alternative.

4.2.4 Long Term Effectiveness And Permanence

Long term risks associated with this alternative are that the target risk levels for all contaminated soils would not be attained. Long term inspections would be necessary. The site inspector/monitor should be aware of these risks and should follow safety procedures. There are no environmental improvements under this alternative. Should this alternative be implemented, the wastes remaining on-site could possibly impact the underlying groundwater and adjacent Kalamazoo River.

4.2.5 Implementability

This alternative is considered readily implementable. A site fence is already installed. All monitoring will be accomplished using the existing network of groundwater monitoring wells. No further site construction work would be required. This alternative does not meet the performance goals established for remedial action under Operable Unit One. There is no likelihood that technical problems will lead to schedule delays since the required security and monitoring systems are already constructed and in place. It is quite possible that future remedial action to address soil and/or groundwater problems would be necessary. No problems are anticipated with the groundwater monitoring. However, problems are anticipated with the surface water and sediment transport into the river. No major coordination problems with regulatory agencies are expected under Alternative 1. Permits for off-site activities are not required under this alternative.

4.2.6 Overall Protection

The No Action Alternative would not result in attainment of the remedial objectives for soils, nor would it reduce the toxicity, mobility, or volume of hazardous materials in the on-site soils. The effectiveness of this alternative in minimizing the baseline human health risks would depend on its success in preventing access to the site.

If the existing security fence fails to prevent access and/or the monitoring system fails to give sufficient warning for timely implementation of an appropriate response action, then the public health may be compromised.

The No Action Alternative would not result in a significant improvement of the natural environment over the baseline condition as described in the RI. Contaminant concentrations would remain unchanged from the baseline levels.

4.2.7 Compliance with ARARs

Probable ARARs for Alternative 1 are summarized in Table 4-1. Draft guidance issued by the MDNR regarding the establishment of soil clean-up limits would not be satisfied under this Alternative. This alternative is not considered to be a reasonable or effective response to the current surface soil conditions.

4.2.8 Costs

Table 4-2 represents the cost for implementing Alternative 1. No capital costs would be incurred under this Alternative. The total annual costs for Operations and Maintenance are estimated to be about $57,750 annually (See Table 4-3). The present worth of this Alternative evaluated over 30 years (at a 10% discount rate) is $544,500.

4.3 Alternative 3 - Stabilization/Capping

4.3.1 Description

Alternative 3 involves excavating and treating all soils above groundwater that contain contaminants above the target clean-up levels. This essentially includes all site soils situated above groundwater. The quantity of waste to be addressed under this Alternative was estimated at

16,800 cubic yards by multilpying the surface area of the site by the average depth to groundwater (7.5 feet). The treatment process would involve stabilization/fixation of the contaminated soils on-site prior to cap construction. This stabilization/fixation process would be followed by construction of a multi-layer capping system. Details regarding cap construction are provided below.

Chemical fixation relies on forming chemical/physical bonds with the fixating agents and the hazardous constituents. Fixating agents typically include cement, lime, or silicates and proprietary additives (see 2.4.2.5). The use of Portland cement can physically incorporate a broad range of waste types. Cement is generally used as a settling agent in silicate-based solidification processes. These methods use a silliceous material together with lime, cement and gypsum. This silliceous material may be fly-ash or other readily available pozzolanic material. A silicate-based process can incorporate a wide range of materials stabilizing metals, waste oils and solvents. Laboratory and/or pilot testing incorporating soil samples from the site would be performed to determine which reagents and fixation processes are suitable for the site. For the purposes of this FS, it has been assumed that fixation/stabilization will be performed on-site using a pug mill or similar equipment. Furthermore, the fixation/stabilization agents to be employed are assumed to be portland cement and the proprietary additive (Chloranan).

The waste soils at the site would be contacted and mixed with the fixating agents chosen and allowed to cure or harden. The stabilized end product would be redeposited at the site in controlled lifts.

Following replacement of the stabilized soil, the entire site would then be capped with an impermeable cover. Construction would consist of installing the following elements in ascending order above the stabilized soils. A three foot thick layer of compacted low permeability clay would be placed. Above the clay, a six inch drainage layer consisting of porous

TABLE 4-2
COST ESTIMATE
ALTERNATIVE 1 - NO ACTION

Item		Capital	Operation and Maintenance Costs		
No.	Description	Cost ($)	Time (Years)	Annual Cost($)	Present Worth($)
1.	Site Inspection	0	1-30	4,200	39,600
2.	Monitoring Program	0	1-30	42,000	396,000
3.	Decontamination	0			
.	Subtotal	0			
4.	Mobilization/ Demobilization (10%)	0			
5.	Engineering (12%)	0			
	Subtotal	0		46,200	435,600
6.	Contingency(25%)		0	11,550	108,900
	Total=	$ 0		$57,750	$544,500

TOTAL PRESENT WORTH OF ALL COST = $544,500

Notes:

1. Present Worth is based on 30 years and at a 10 percent discount rate.
2. See Table 4-3 for Monitoring Program costs.
3. 1050 ft. of fence at $1.00/ft for site inspection.
4. Decontamination is assumed at 6% of the Monitoring Program.
5. Site inspection/monitoring program evaluation done quarterly.

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TABLE 4-3
COST ESTIMATE FOR
RESPONE OPTION 1 - NO ACTION

Item No.	Description	Unit	Quantity	Annual Costs Unit Cost ($)	Total Cost ($)
1.	Sampling-Labor	Event	4	2,500	10,000
2.	Sample Analysis	Sample	20	1,300	26,000
3.	Sample Duplicates	Sample	4	1,300	5,000
4.	Trip Blank	Sample	4	1,300	5,200
5.	Sampling Report Preparation (Engineering Certification)	Event	4	4,000	16,000
					$62,400
6.	Site Inspection	Event	4	1,050	$ 4,200
	TOTAL ANNUAL COSTS =				$66,600

Notes:

1. Total annual costs are based on quarterly sampling.

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soil (i.e. sand), covered by geotextile fabric would be placed. A three foot thick layer of compacted soil (gravel) would be placed over the drainage layer to serve as frost protection for the clay and liner layers. The final layer overlying the site will consist of an 8-inch layer of topsoil to support the growth of grass. Once the cover has been constructed it must be periodically maintained to prevent the growth of trees or shrubs whose roots could compromise the integrity of the liner system.

4.3.2 Reduction of MTV

This alternative would result in a substantial reduction in the mobility of the metals at the site through the creation of physical barriers and chemical bonds. Data reported by EPA showed reduction in the migration potential of lead, as measured by TCLP leaching tests, ranged from 55.03-99.95%. TCLP leachate concentrations ranged from 0.0093-0.0706 ug leached/ug in soil for the untreated soils, and 0.000036-.000540 ug leached/ug present for the stabilized mass. Chromium, cadmium, copper, nickel and zinc were also found to be immobilzed under this technology Arsenic was not examined under this demonstration. The mobility of the semi-volatile organic constituents would not be appreciably reduced under this Alternative (EPA/540/A5-89/001, May 1989). Neither the toxicity nor the volume of hazardous substances would be reduced. A substantial volume increase of the order of 100% will result with the use of the Chloranan additive. This alternative addresses the principal threats posed by the site, however, these remedial measures do not provide permanent destruction or detoxification of the chemicals of concern.

The contaminant residuals that remain are the fixated mass of soil covered with an impermeable cap. Although the wastes have been treated to reduce their mobility, there are long term risks posed by residuals. However, the remedial objective of reducing the risks due to direct contact with the contaminants will have been met.

4.3.3 Short-Term Effectiveness

The risks to the community that must be addressed during remedial action are possible inhalation of dust and/or vapors omitted during the complementation of the fixation process. As indicated on Table 3-1 dust control measures would be instituted to control these risks. The potential for inhalation of vapors and/or direct contact exposures to occur to site workers during site activities can be effectively mitigated. Site workers would utilize conventional respiratory and dermal protective equipment and clothing.

Environmental impacts associated with this alternative include potential transport of soils into the adjacent river via surface water runoff during site activities. Sedimentation control barriers placed between the river and the disturbed areas could effectively control this.

Shortly after this Alternative has been completed, response objectives could be met. The following objectives established for Operable Unit One would be satisfied:

- Preventing direct contact with contaminated soils; and

- Preventing inhalation and ingestion of contaminated soils.

The objective of removing the source materials from the site would not be satisfied.

A design and construction period of 8 to 10 months is considered realistic for this Alternative.

4.3.4 Long Term Effectiveness and Permanence

In the long-term, this Alternative would not attain target risk levels for all contaminated soils as set forth in section 2.2. The risks posed by those soils situated below the groundwater table and containing contaminants above clean-up levels would not be addressed, however, any such concerns will be addressed by Operable Unit Two. Stabilization and construction of a multi-layer capping system should effectively prevent further vertical migration of hazardous substances into the groundwater system. Long term inspections/maintenance would be necessary to ensure the adequacy of this Alternative.

Long-term uncertainties regarding potential damage to the capping system during flooding could be problematic. Severe flood damage could result in the need to replace elements of (or the entire) capping system. The risks posed by severe damage to the capping system are considered significant under this Alternative because the underlying stabilized soils could then be re-exposed to the environment and subject to direct contact, ingestion or inhalation. Residual uncertainties involve potential failures in the synthetic liner in the capping system and the resulting potential for leaching of contaminants from the solidified mass.

Long-term permanence of the capping system under this Alternative would not be compromised by seismic activity. There are political jurisdictions located in the State of Michigan as identified in Appendix VI of 40 CFR 264 for which compliance with the seismic location standard must be demonstrated. Therefore, the site is probably not located within 200 feet of a fault which has experienced displacement in Holocene time.

There is also some potential for long term durability problems of the solidified mass. Under the site demonstration, the solidified mass was subjected 12-cycle wet/dry and freeze/thaw weathering tests. There was no loss of unconfined compressive strength, and extremely low absolute weight losses. Although the weathering tests were more severe than weathering under actual field conditions, EPA concluded that the tests only indicate short-term durability. This was due to the limited number of cycles involved. Quantification of the life expectancy of the solidified mass was not possible (EPA/540/A5-89/001, May 1989).

Long term durability may be compromised in areas where the solidified mass can become water-saturated. Under these conditions, weathering cycles, particularly freeze/thaw, may be detrimental to the highly porous treated waste. Fracturing due to freezing of the absorbed water may occur. This is a limited concern under this Alternative due to the use of a multi-layer cap to minimize infiltration into the waste. Some water may be absorbed into those wastes present near the water table (average depth 7.5 feet), but this is well below the frost line.

4.3.5 Implementability

The individual technologies utilized in this Alternative are conventional, well demonstrated, and commercially available. Stabilization can be accomplied by using conventional mixing equipment such as pug mill. Construction of the capping system and site backfilling/restoration can also be performed using common with earth moving equipment.

The Stabilization technology has been demonstrated in several projects under EPA-sponsorship. The Douglassville, PA and Hialeah, FL demonstrations under EPA's SITE program were described in Section 2.4.2.5. A third EPA demonstration involved treating a surrogate soil containing a wide range of contaminants typically found at CERCLA sites. This demonstration included seven metals including lead, zinc, arsenic, copper, chromium and nickel. Interestingly, these are the predominant heavy metals present at the Auto-Ion site.

EPA prepared four soil types and stabilized them using three common binding agents. Soil type 2 contained low levels of organics (2080 mg/kg volatiles) and low levels of heavy metals (1000 mg/kg total metals). This level of contamination is similar to that present at the Auto-Ion site.

The three agents used in the demonstration included portland cement (Type 1), lime kiln dust, and a 50:50 (by wt.) mixture of lime kiln dust and fly ash. Samples were treated and allowed to cure, after which samples for unconfined compressive strength (UCS) were obtained. Samples with a UCS greater than 50 psi were subjected to total metal nad TCLP analyses.

The findings of the demonstration showed that copper, nickel and zinc were readily immobilized by the three agents tested. Arsenic and lead immobilization were dependent upon the binder used. Chromium data were not interpretable because of its low initial concentration. As a group, these metals showed the following reductions in TCLP leachate concentrations:

- Portland Cement (28 days) 89.8%
- Lime Kiln Dust (28 days) 94.5%

Based on the findings of this demonstration and the similarity of the wastes treated to those present at the Auto-Ion Site, it appears that heavy metals present at the site can be successfully immobilized. However, treatability testing will be necessary to identify proper mix design and evluate the reduction in mobility.

Several implementation issues were identified in the SITE demonstration of the Chloranan additive technology. Due to the large volume increases associated with treating low moisture content wastes such as soils, the capability to stage and relocate the solidified material may be required. This would be very difficult at the Auto-Ion site due to the limited surface area of the site, and the need to excavate over the entire surface of the site. Further space restrictions would be posed by the need to locate treatment equipment on-site.

A second implementation problem is the significant volume increase. Since the entire surface of the site would be excavated to a depth of about 7.5 feet, and since a 100% volume increase was reported to a be typical for the chloranan technology, backfilling of the solidified mass would result in final grades (before cap construction) of at least 7.5 feet above existing grade. The site would thus resemble a small mound in an otherwise flat floodplain area. This elevated mound of waste would be more susceptible to washout during flood events than a cap constructed at existing grade.

It is currently anticipated that future remedial action may be necessary to address groundwater problems in the area. The implementation of this alternative as a first operable unit would not adversely impact subsequent response actions.

Future monitoring of the site soils would not be necessary after completion of the alternative. Post implementation groundwater monitoring may be necessary for the evaluation of subsequent remedial action.

Certain administrative requirements are associated with implementation of Alternative 3. Coordination between the Steering Committee and regulatory agencies including EPA and MDNR will be required for review and approval of:

- technical plans and specifications;
- scope changes and/or deviations from the specifications;
- selected contractor(s).

Additional coordination with the Army Corps of Engineers, may be necessary for work in a flood plain or floodway. Long term administrative coordination would be required for reviewing site inspection and monitoring reports. None of the administrative requirements identified above present substantial or insurmountable difficulties.

4.3.6 Overall Protection

Short-term risks associated with excavation of contaminated soils can be addressed by implementing relatively straight forward controls such as water application for dust control, sediment barriers for erosion control, utilizing protective equipment for control of exposures to on-site workers. In the long-term, implementation of this Alternative should benefit groundwater conditions underlying the site be reducing the mobility of certain hazardous consistents and eliminating hydraulic conditions that may be promoting continued contaminant influx. There is a potential for adverse environmental impacts to occur if the liner of the capping system fails.

This Alternative does not comply with all identified ARARs. Redeposition of wastes on-site constitutes land disposal and the absence of a liner and leachate collection system is in conflict with RCRA design standards for landfills.

4.3.7 Compliance with ARARS

Probable ARARs for Alternative 3 are summarized in Table 4-1. Draft guidance issued by the MDNR regarding the establishment of soil clean-up limits were considered under this Alterhative. This Alternative would not comply with the WMD/MDNR Draft Guidance because stabilized waste with contaminant concentrations exceeding site background would be redeposited on-site. This Alternative would not comply with the design standards for land disposal facilities as set forth in RCRA and the corresponding rules as set forth in 40 CFR 264 .301 and .310. These standards specify that the final cover must be designed and constructed to provide long-term minimization fo infiltration, minimum maintenance, promote drainage, minimize erosion, and accommodate subsidence. Additionally, the cap must have a permeability less than the natural subsoils present. The capping system included in this Alternative would provide long-term minimization of infiltration and promote drainage. However, it would not effectively minimize erosion, particularly during flood events.

Implementation of this alternative would, however, significantly improve the conditions at the site to the point where the remedial objectives for Operable Unit One would be met.

This Alternative would comply with the seismic location standard specified in 40 CFR 264.18(a). There are no political jurisdictions located in the state of Michigan, as identified in Appendix VI of 40 CFR 264, for which compliance with the seismic location standard must be demonstrated. Although faulting is present in certain parts of Michigan, no faults which have experienced displacement in Holocene time were identified in the Kalamazoo area. A Silurian age fault located in Kalamazoo County and about 2 miles from the site was identifed in the Hydrogeologic Atlas of Michigan prepared by Western Michigan University (1981). This appears to be the nearest mapped fault to the site.

This Alternative would not comply with the floodplain location standard in 40 CFR 264.18 (b). This standard requires that a facility located in a 100-year floodplain must be designed, constructed, operated and maintained to prevent washout of any hazardous waste by a 100-year flood, unless certain demonstrations can be made. The Auto-Ion site is located in the 100-year floodplain of the Kalamazoo River. Although scour protection has been included in the capping system for this Alternative, the required demonstration regarding removal of waste in the event of flood cannot be made. Similarly, the demonstration regarding no adverse effects in the event of washout can probably not be made.

4.3.8 Cost

The estimated costs for Alternative 3 are summarized in Table 4-4. Major capital cost elements include: labor and equipment costs for excavation and stabilization; cap material; and placement costs. Stabilization costs were estimated through discussion with two vendors (VFL Technology Corp. and Enreco, Inc.). Additionally economic information generated during EPA's site demonstration were considered (unit cost of $97-207/ton of soil). Total capital costs are estimated to be $1,857,600, with annual operation and maintenance costs of $70,980 (See Table 4-5). The thirty year present worth associated with the annual operation and maintenance costs is $669,350. The total estimated present worth is about $2,527,000.

4.4 Alternative 4 - Vadose Zone Excavation/Disposal

4.4.1 Description

Alternative 4 consists of a combination of the partial excavation and off-site land disposal technologies. Under this alternative, essentially all soil located within the site boundaries and situated above groundwater table will be excavated and shipped to off-site disposal. The quantity of waste to be addressed under this Alternative was estimated at 16,800 cubic yards by multiplying the surface areas of the site by the average depth to groundwater (7.5 feet).

Due to the relatively shallow depth to groundwater, soil removal would be accomplished using conventional construction equipment such as backhoes and/or front end loaders. The wastes would then be transferred into tractor trailers for shipping to the disposal site. At the disposal site the soils would be placed into an approved land disposal cell.

The excavated portions of the site would be backfilled using clean, imported bank run gravel (or other suitable material). Backfilling would be accomplished in controlled lifts with mechanical compaction. The site would be graded to promote drainage and revegetation.

Operation and maintenance activities under this alternative would consist of quarterly site inspections by a professional engineer to examine the site for differential settling, erosion, and security system integrity.

TABLE 4-4
COST ESTIMATE - ALTERNATIVE 3
STABILIZATION/CAPPING

Item No.	Description		Total Cost($)
1.	Excavation, Stabilization, and Backfilling(1)		
		Labor	191,760
		Equipment	178,835
		Materials	308,925
		Subcontractor/Expenses	54,780
		Subtotal	$ 734,300
2.	Installation of Synthetic Liner (2)		
		Labor	9,720
		Equipment	2,790
		Materials	52,270
		Subcontractor/Expenses	3,760
		Subtotal	$ 68,540
3.	Backfill and Clay Cap Placement(3)		
		Labor	38,400
		Equipment	11,600
		Materials	113,260
		Subcontractors/Expenses	8,975
		Subtotal	$ 192,235
4.	Install Collector Manifold, Pipe, Stone, Filter Fabric		
		Labor	16,800
		Equipment	.5,100
		Materials	16,100
		Expenses	2,800
		Subtotal	$ 40,800
5.	Final Grade and Seed All Areas (5)		
		Labor	4,680
		Equipment	1,350
		Materials	540
		Subtotal	$ 7,170
6.	Support Services, Site Preparation, etc.		
		Labor	99,360
		Equipment	37,075
		Materials	11,950
		Subcontractors/Expenses	84,400
		Subtotal	$ 232,785

(CL5204B/1)

TABLE 4-4
COST ESTIMATE - ALTERNATIVE 3
STABILIZATION/CAPPING
(Continued)

Item No.	Description	Total Cost($)
	Estimated Total Items	1,275,830
	Engineering (12%)	153,100
	Project Estimate	1,428,930
	Contingency (30%)	428,670
	Project Estimate with Contingency =	$1,857,600
		(Round to $1,858,000)

Notes:

(1) Estimated volume of excavation, stabilization = 16,800 cu. yds. Assumes 1:1 stabilization with chloranan additive.
(2) Estimated installation area = 65,340 sq. ft.
(3) Estimated quantities for backfill and clay cap placement: Drainage Layer = 3,355 cu. yds; Clay barrier = 3,355 cu. yds; soil fill is stabilized soil; top soil = 1,120 cu. yds.
(4) Estimated length of trench = 1040 linear feet, Rap Rap = 12 tons.
(5) Estimated area for the final grade and seeding = 65,340 sq. ft.

(CL5204B/1)

TABLE 4-5

ANNUAL COST ESTIMATE - ALTERNATIVE 3
STABILIZATION/CAPPING

Item No.	Item Description	Unit	Quantity	Annual Costs Unit Cost ($)	Annual Costs Total Cost ($)
1.	Site Inspection	Event	4	$1,050	$ 4,200
2.	Sampling-Labor	Event	4	$2,500	$ 10,000
3.	Groundwater Analysis	Sample	24	$ 500	$ 12,000
3.	Sample Duplicates	Sample	4	$ 500	$ 2,000
4.	Trip Blank	Sample	4	$ 500	$ 2,000
5.	Sampling Report Preparation (Engineering Certification)	Event	4	$4,000	$ 16,000
6.	Cap Maintenance	Event	6	$ 750	$ 4,500
		TOTAL ANNUAL COSTS =			$ 50,700
		Engineering (12%)			6,084
		Subtotal			$ 56,784
		Contingency (25%)			$ 14,196
		TOTAL			$ 70,980
		Present Worth of Annual Costs =			$669,350

NOTE:

1. Present Worth based on 30 years and at a 10 percent discount rate.

(CL5204B/1)

4.4.2 Reduction of MTV

This alternative provides for the complete removal of contaminants from the Vadose Zone and, therefore, with regards to the site itself, there is no longer a MTV concern from these contaminants. Although the MTV of the removed soils are not reduced, the soils will be disposed of in an acceptable controlled facility such that they no longer pose an unacceptable risk.

4.4.3 Short Term Effectiveness

The level of protection and afforded to the local community and on-site workers during construction may be compromised by certain elements of work under this Alternative. During waste excavation and loading activities, dusts could be generated and transported off-site. As shown in Table 3-1, dust control measures such as water application, have been incorporated into Alternative 4 as a means of mitigating short-term impacts associated with dust emissions. There is also a potential for direct contact and/or inhalation exposures to occur to site workers during waste handling activities. Site workers can be effectively protected against these risks by utilizing conventional respiratory and dermal protective equipment and clothing.

Environmental impacts associated with this alternative include potential transport of excavated materials into the adjacent river via surface water runoff. This could be effectively mitigated by the use of sediment control barriers between the disturbed areas and the river. Containment features could be incorporated into the design of the staging area to prevent transport of staged wastes.

Response objectives could be met shortly after initiation of the work under this Alternative. It is likely that Alternative 4 would satisfy the following objectives established for Operable Unit One:

- Preventing direct contact with contaminated soils;

- Preventing inhalation and ingestion of contaminated soils;

Concerns regarding contaminants present in soils below the groundwater table that would not be removed under this Operable Unit will be addressed as part of a subsequent Operable Unit.

A design and construction period of less than 10 months is considered realistic for this Alternative.

4.4.4 Long Term Effectiveness and Permanence

In the long term, this Alternative would not attain target risk levels for all contaminated soils as set forth in Section 2.2. Those soils situated below the groundwater table which contain contaminants above the clean-up levels would not be addressed. The controls established under this Alternative should be both adequate and reliable. Long-term inspections and periodic repairs to the security and monitoring systems would be necessary to ensure the adequacy of this Alternative.

Land disposal of the excavated soils pose some uncertainty regarding containment in the selected land disposal facility. Potential uncertainties include failures in the liner and leachate collection systems at the selected land disposal facility, and the resultant release of hazardous substances to the environment.

4.4.5 Implementability

The individual technologies utilized in this Alternative are conventional, well demonstrated, and commercially available. Excavation can be accomplished using common earth moving equipment and transportation can be accomplished using conventional over-the-road tractor trailers. Off-site land disposal of the excavated soils can be achieved at a number of permitted facilities (provided they are in compliance with EPA's off-site disposal policy). Several off-site land disposal facilities, permitted to accept various hazardous wastes, are located within reasonable distances from the site. The facilities considered in this evaluation included:

- Wayne Disposal of Wayne, Michigan (125 miles);
- CECOS International near Mansfield, Ohio (230 miles);
- Envirosafe Services, Inc. of Oregon, Ohio (175 miles);
- CWM of Indiana (Fort Wayne, IN; 125 miles);
- CWM of Illinois (Chicago, IL; 130 miles);
- Peoria Disposal Co. of Peoria, Illinois (275 miles).

Each of these facilities were contacted regarding acceptability of the waste to be excavated under Operable Unit One. None of the facilities indicated capacity or acceptability problems, provided the waste meets any applicable treatment standards.

It is currently anticipated that future remedial actions may be necessary to address groundwater problems in the area. The implementation of this Alternative as a first operable unit would not adversely impact subsequent response action(s).

Further monitoring of the site soils and potential exposure/migration pathways would not be necessary after completion of this Alternative. Post-implementation groundwater monitoring may be necessary for the evaluation of subsequent remedial action.

Certain administrative requirements are associated with implementation of Alternative 4. Coordination between the steering committee and regulatory agencies including EPA and MDNR will be required for review and approval of:

- technical plans and specifications;
- scope changes and/or deviations from the specifications;
- selected contractor(s) and disposal facilities.

Additional coordination with the Army Corps of Engineers may be necessary for work in a flood plain or floodway. Long term administrative coordination would be required for reviewing site inspection and monitoring reports. None of the administrative requirements identified above present substantial or insurmountable difficulties.

4.4.6 Overall Protection

Short term risks associated with excavation of contaminated soils can be addressed by implementing relatively straight forward controls such as water application for dust control, sediment barriers for erosion, and utilizing protective equipment for control of exposures to on-site workers. In the long term, implementation of this Alternative should benefit groundwater conditions underlying the site by eliminating a probable source of continued contaminant influx.

There is a potential for adverse environmental impact to occur if the liner and/or leachate collection systems of the selected land disposal facility fail.

4.4.7 Compliance With ARARs

Probable ARARs for Alternative 4 are summarized in Table 4-1. Draft guidance issued by the MDNR regarding the establishment of soil clean-up limits were considered under this Alternative. This Alternative would be a reasonable and effective response to the current situation wherein surface soils have been impacted by past operating practices.

This Alternative involves the off-site land disposal of excavated wastes. The land disposal restrictions contained in 40 CFR 268 were identified as potential ARARs for Alternative 4. Due to the fact that it is currently uncertain whether the wastes to be excavated under this Alternative contain wastes subject to the land disposal restrictions, definitive conclusions regarding the applicability and compliance with 40 CRF 268 cannot be drawn. In the event that the land diposal restrictions are determined to be applicable, the treatment standards for metals might not be achieved under this Alternative.

Identified action specific ARARs can be met with this Alternative. Certain permits and approvals will be necessary of the off-site elements of this Alternative.

4.4.8 Cost

The estimated costs for Alternative 4 are summarized in Table 4-6. Major capital cost labor and equipment costs for excavation, staging and loading, transportation costs, and disposal fees, and backfill material and placement costs. Transportation and disposal costs were determined through contacts with the six land disposal facilities considered in this evaluation (see Table 4-7). Transportation costs ranged from $24-$47/ton and disposal costs ranged from $75-135/ton.

Total capital costs are estimated to be $3,755,250, with annual operation and maintenance cost of $5,900 (See Table 4-8). The thirty year present worth associated with the annual operation and maintenance costs is $55,560. The total estimated present worth is about $3,811,000.

4.5 Alternative 5 - Selected Vadose Zone Excavation/Disposal

4.5.1 Description

Alternative 5 consists of a combination of the partial excavation and off-site land disposal technologies. Under this alternative, some of the

TABLE 4-6

COST ESTIMATE - ALTERNATIVE 4
VADOSE ZONE EXCAVATION/DISPOSAL

Item No.	Description	Total Cost($)	
1.	Excavate and load contaminated soil		
	Labor	$129,720	
	Equipment	109,510	
	Materials	44,450	
	Subcontractor/Expenses	51,120	
	Subtotal		$ 334,800
2.	Transportation		$ 371,000
3.	Disposal		$ 1,764,000
4.	Backfill and Restoration		
	Labor	36,000	
	Equipment	13,050	
	Materials	96,770	
	Subcontractor/Expenses	6,710	
	Subtotal		$ 152,530
5.	Support Services & Restoration		
	Labor	84,300	
	Equipment	20,475	
	Materials	11,000	
	Subcontractors/Expenses	55,980	
	Subtotal		$ 171,755
	Estimated Total Items		$ 2,794,085
	Engineering (12%)		$ 335,290
	Total Estimate		$ 3,129,375
	Contingency (20%)		$ 625,875
	Project Estimate with Contingency =		$ 3,755,250

(CL5204B/1)

TABLE 4-7
SUMMARY OF TRANSPORTATION AND DISPOSAL COSTS

DISPOSAL FACILITY/LOCATION	TRANSPORTATION(1)	DISPOSAL
Wayne Disposal, Inc. Wayne, Michigan	\$ 23.86	\$110-115/CY
CECOS International, Inc. Mansfield, Ohio	\$ 40.09	\$ 75/CY
Envirosafe Services, Inc. Oregon, Ohio	\$ 31.59	\$128/CY
Chemical Waste Management, Inc. Fort Wayne, Indiana	\$ 23.86	\$135/ton
Chemical Waste Management, Inc. Chicago, Illinois	\$ 24.64	\$105/ton
Peoria Disposal Co. Peoria, Illinois	\$ 47.04	\$75-100/ton

NOTES:

(1) Transportation costs were derived assuming 22 tons per load, a density of 85 lb/ft^3, and a unit price of \$3.40 per loaded mile.

TABLE 4-8

ANNUAL COST ESTIMATE - ALTERNATIVE 4
VADOSE ZONE EXCAVATION/DISPOSAL

Item No.	Description	Unit	Quantity	Annual Costs Unit Cost ($)	Total Cost ($)
1.	Site Inspection	Event	4	$1,050	$ 4,200
	Total Annual Cost				$ 4,200
	Engineering (12%)				504
	Subtotal				$ 4,704
	Contingency (25%)				$ 1,176
	TOTAL ANNUAL COST				$ 5,880
	PRESENT WORTH OF ANNUAL COSTS =				$55,650

soils located within the site boundaries and situated above groundwater table will be excavated and shipped to off-site disposal. The quantity to be excavated under this Alternative was estimated to be 7160 cubic yards and is based on the clean-up levels specified in Task 2-1, Column 6.

Due to the relatively shallow depth to groundwater, soil removal would be accomplished using conventional construction equipment such as backhoes and/or front end loaders. The wastes would then be transferred into tractor trailers for shipping to the disposal site. At the disposal site the soils would be placed into an approved land disposal cell.

The excavated portions of the site would be backfilled using clean, imported bank run gravel (or other suitable material). Backfilling would be accomplished in controlled lifts with mechanical compaction. The site would be graded to promote drainage and revegetation.

Operation and maintenance activities under this alternative would consist of quarterly site inspections by a professional engineer to examine the site for differential settling, erosion, and security system integrity.

4.5.2 Reduction of MTV

This alternative provides for the removal of soils containing contaminants where clean-up levels from the Vadose Zone area and, therefore, with regards to the site itself, there is a significant reduction in MTV concerns from these contaminants. Although the MTV of the removed soils are not reduced, the soils will be disposed of in an acceptable, controlled facility such that they no longer pose an unacceptable risk.

4.5.3 Short Term Effectiveness

The level of protection and afforded to the local community and on-site workers during construction may be compromised by certain elements of work under this Alternative. During waste excavation and loading activities, dusts could be generated and transported off-site. As shown in Table 3-1, dust control measures such as water application, have been incorporated into Alternative 5 as a means of mitigating short-term impacts associated with dust emissions. There is also a potential for direct contact and/or inhalation exposures to occur to site workers during waste handling activities. Site workers can be effectively protected against these risks by utilizing conventional respiratory and dermal protective equipment and clothing.

Environmental impacts associated with this alternative include potential transport of excavated materials into the adjacent river via surface water runoff. This could be effectively mitigated by the use of sediment control barriers between the disturbed areas and the river. Containment features could be incorporated into the design of the staging area to prevent transport of staged wastes.

Response objectives could be met shortly after initiation of the work under this Alternative. It is likely that Alternative 5 would satisfy the following objectives established for Operable Unit One:

- Preventing direct contact with contaminated soils;
- Preventing inhalation and ingestion of contaminated soils;

Concerns regarding contaminants present in soils below the groundwater table that would not be removed under this Operable Unit will be addressed as part of a subsequent Operable Unit.

A design and construction period of less than 10 months is considered realistic for this Alternative.

4.5.4 Long Term Effectiveness and Permanence

In the long term, this Alternative would not attain target risk levels for all contaminated soils as set forth in Section 2.2. Those soils situated below the groundwater table which contain contaminants above the clean-up levels would not be addressed. The controls established under this Alternative should be both adequate and reliable. Long-term inspections and periodic repairs to the security and monitoring systems would be necessary to ensure the adequacy of this Alternative.

Land disposal the excavated soils pose some uncertainty regarding containment in the selected land disposal facility. Potential uncertainties include failures in the liner and leachate collection systems at the selected land disposal facility, and the resultant release of hazardous substances to the environment.

4.5.5 Implementability

The individual technologies utilized in this Alternative are conventional, well demonstrated, and commercially available. Excavation can be accomplished using common earth moving equipment and transportation can be accomplished using conventional over-the-road tractor trailers. Off-site land disposal of the excavated soils can be achieved at a number of permitted facilities (provided they are in compliance with EPA's off-site disposal policy). As discussed under Alternative 4, six land disposal facilities located within reasonable distances were considered in this evaluation. No capacity or acceptability problems were identified.

It is currently anticipated that future remedial actions may be necessary to address groundwater problems in the area. The implementation of this Alternative as a first operable unit would not adversely impact subsequent response action(s).

Further monitoring of the site soils and potential exposure/migration pathways would not be necessary after completion of this Alternative. Post-implementation groundwater monitoring may be necessary for the evaluation of subsequent remedial action.

Certain administrative requirements are associated with implementation of Alternative 5. Coordination between the steering committee and regulatory agencies including EPA and MDNR will be required for review and approval of:

- technical plans and specifications;
- scope changes and/or deviations from the specifications;
- selected contractor(s) and disposal facilities.

Additional coordination with the Army Corps of Engineers may be necessary for work in a flood plain or floodway. Long term administrative coordination would be required for reviewing site inspection and monitoring reports. None of the administrative requirements identified above present substantial or insurmountable difficulties.

4.5.6 Overall Protection

Short term risks associated with excavation of contaminated soils can be addressed by implementing relatively straight forward controls such as water application for dust control, sediment barriers for erosion, and utilizing protective equipment for control of exposures to on-site workers. In the long term, implementation of this Alternative should benefit groundwater conditions underlying the site by eliminating a probable source of continued contaminant influx.

There is a potential for adverse environmental impact to occur if the liner and/or leachate collection systems of the selected land disposal facility fail.

4.5.7 Compliance With ARARs

Probable ARARs for Alternative 5 are summarized in Table 4-1. Draft guidance issued by the MDNR regarding the establishment of soil clean-up limits were considered under this Alternative. This Alternative would be a reasonable and effective response to the current situation wherein surface soils have been impacted by past operating practices.

This Alternative involves the off-site land disposal of excavated wastes. The land disposal restrictions contained in 40 CFR 268 were identified as potential ARARs for Alternative 5. Due to the fact that it is currently uncertain whether the wastes to be excavated under this Alternative contain wastes subject to the land disposal restrictions, definitive conclusions regarding the applicability and compliance with 40 CFR 268 cannot be drawn. In the event the land disposal restricts are determined to be applicable, the treatment standards for methods might not be achievable under this Alternative.

Identified action specific ARARs can be met with this Alternative. Certain permits and approvals will be necessary of the off-site elements of this Alternative.

4.5.8 Cost

The estimated costs for Alternative 5 are summarized in Table 4-9. Major capital cost labor and equipment costs for excavation, staging and loading, transportation costs, and disposal fees, and backfill material and placement costs. As discussed under Alternative 4, contacts with the six land disposal facilities considered in this evaluation formed the basis for the transportation and disposal costs. Total capital costs are estimated to be \$3,373,000, with annual operation and maintenance cost of \$5,900 (See Table 4-10). The thirty year present worth associated with the annual operation and maintenance costs is \$55,560. The total estimated present worth is \$3,428,560.

TABLE 4-9

COST ESTIMATE - ALTERNATIVE 5
SELECTED VADOSE ZONE EXCAVATION/DISPOSAL

Item No.	Description	Total Cost($)	
1.	Excavate and load contaminated soil		
	Labor	$ 55,200	
	Equipment	46,600	
	Materials	19,000	
	Subcontractor/Expenses	24,600	
	Subtotal		$ 145,400
2.	Transportation		$ 158,120
3.	Disposal		$ 751,800
4.	Backfill and Restoration		
	Labor	16,000	
	Equipment	5,800	
	Materials	55,320	
	Subcontractor/Expenses	3,105	
	Subtotal		$ 80,225
5.	Support Services & Restoration		
	Labor	40,120	
	Equipment	9,000	
	Materials	9,150	
	Subcontractors/Expenses	50,350	
	Subtotal		$ 108,620
	Estimated Total Items		$ 1,244,165
	Engineering (12%)		$ 149,300
	Total Estimate		$ 1,393,465
	Contingency (20%)		$ 278,695
	Project Estimate with Contingency =		$ 1,672,160
			(Round to $1.67M)

(CL5204B/1)

TABLE 4-10

ANNUAL COST ESTIMATE - ALTERNATIVE 5
SELECTED VADOSE ZONE EXCAVATION/DISPOSAL

Item No.	Description	Unit	Quantity	Annual Costs Unit Cost ($)	Total Cost ($)
1.	Site Inspection	Event	4	$1,050	$ 4,200
	Total Annual Cost				$ 4,200
	Engineering (12%)				504
	Subtotal				$ 4,704
	Contingency (25%)				$ 1,176
	TOTAL ANNUAL COST				$ 5,880
	PRESENT WORTH OF ANNUAL COSTS =				$55,650

4.6 Alternative 7 - Vadose Zone Excavation/Stabilization/Disposal

4.6.1 Description

Alternative 7 consists of a combination of the partial excavation, stabilization and off-site land disposal technologies. Under this alternative, essentially all soil located within the site boundaries and situated above groundwater table will be excavated, stabilized, and shipped to off-site disposal. The quantity of waste to be addressed under this Alternative was estimated at 16800 cubic yards by multiplying the surface area of the site by the average depth to groundwater (7.5 feet).

Due to the relatively shallow depth to groundwater, soil removal would be accomplished using conventional construction equipment such as backhoes and/or front end loaders. The excavated soils would be treated, as necessary to meet land ban standards for soils contaminated with F006 wastes by stabilization/fixation prior to off-site disposal. Only those soils that are determined to be contaminated with F006 wastes and that would not pass the applicable TCLP test (40 CFR 268.41) would be treated prior to disposal. All other soils excavated to the clean-up levels shown in Table 2-1, Column 6 would be disposed at an RCRA approved facility. It is assumed that the stabilization/fixation agents chosen would be portland cement and a proprietary additive (chloranan). For the purposes of this FS it has been assumed that pre-disposal treatment of the excavated soils will be performed on-site using a pug mill or similar mixing equipment. The wastes would then be transferred into tractor trailers for shipping to the disposal site. At the disposal site the soils would be placed into an approved land disposal cell.

The excavated portions of the site would be backfilled using clean, imported bank run gravel (or other suitable material). Backfilling would be accomplished in controlled lifts with mechanical compaction. The site would be graded to promote drainage and revegetation.

Operation and maintenance activities under this alternative would consist of quarterly site inspections by a professional engineer to examine the site for differential settling, erosion, and security system integrity.

4.6.2 Reduction of MTV

This alternative provides for the complete removal of contaminants from the Vadose Zone and, therefore, with regards to the site itself, there is no longer a MTV concern from these contaminants. The stabilization/fixation treatment process will reduce the mobility of the inorganic contaminants present in the excavated soils (see Section 4.3.2). A substantial volume increase on the order of 100% will result with the use of the chloranan additive. Although the toxicity and volume of the removed soils are not reduced, the soils will be disposed of in an acceptable controlled facility such that they no longer pose an unacceptable risk.

4.6.3 Short Term Effectiveness

The level of protection and afforded to the local community and on-site workers during construction may be compromised by certain elements of work under this Alternative. During waste excavation, treatment and loading activities, dusts could be generated and transported off-site. As shown in Table 3-1, dust control measures such as water application, have been incorporated into Alternative 7 as a means of mitigating short-term impacts associated with dust emissions. There is also a potential for direct contact and/or inhalation exposures to occur to site workers during waste handling activities. Site workers can be effectively protected against these risks by utilizing conventional respiratory and dermal protective equipment and clothing.

Environmental impacts associated with this alternative include potential transport of excavated materials into the adjacent river via surface water runoff. This could be effectively mitigated by the use of sediment control barriers between the disturbed areas and the river. Containment features could be incorporated into the design of the staging area to prevent transport of staged wastes.

Response objectives could be met shortly after initiation of the work under this Alternative. It is likely that Alternative 7 would satisfy the following objectives established for Operable Unit One:

- Preventing direct contact with contaminated soils;

- Preventing inhalation and ingestion of contaminated soils;

Concerns regarding contaminants present in soils below the groundwater table that would not be removed under this Operable Unit will be addressed as part of a subsequent Operable Unit.

A design and construction period of less than 10 months is considered realistic for this Alternative.

4.6.4 <u>Long Term Effectiveness and Permanence</u>

In the long term, this Alternative would not attain target risk levels for all contaminated soils as set forth in Section 2.2. Those soils situated below the groundwater table which contain contaminants above the clean-up levels would not be addressed. The controls established under this Alternative should be both adequate and reliable. Long-term inspections and periodic repairs to the security and monitoring systems would be necessary to ensure the adequacy of this Alternative.

Land disposal of the excavated soils pose some uncertainty regarding containment in the selected land disposal facility. Potential uncertainties include failures in the liner and leachate collection systems at the selected land disposal facility, and the resultant release of hazardous substances to the environment.

4.6.5 Implementability

The individual technologies utilized in this Alternative are conventional, well demonstrated, and commercially available. Excavation can be accomplished using common earth moving equipment and transportation can be accomplished using conventional over-the-road tractor trailers. As discussed under Alternative 4, six land disposal facilities located within reasonable distances were considered in this evaluation. No capacity or acceptability problems were identified. Stabilization/fixation can be accomplished on-site using a pug mill or similar mixing equipment. Sufficient space is available for the on-site treatment equipment. A treatability study would be necessary to identify the most useful stabilization/fixation agents and the appropriate reagent dosages to be used (see Section 4.3.5). Off-site land disposal of the excavated soils can be achieved at a number of permitted facilities (provided they are in compliance with EPA's off-site disposal policy).

The space constraints discussed in Section 4.3.5 also apply to the implementation of this Alternative. The capability to stage and relocate the solidified mass may be required due to the large volume increases expected. This would be very difficult at the Auto-Ion Site due to the limited surface area of the site, and the need to excavate over the entire surface area of the site. Further space restrictions would be posed by the need to locate treatment equipment on-site.

It is currently anticipated that future remedial actions may be necessary to address groundwater problems in the area. The implementation of this Alternative as a first operable unit would not adversely impact subsequent response action(s).

Further monitoring of the site soils and potential exposure/migration pathways would not be necessary after completion of this Alternative. Post-implementation groundwater monitoring may be necessary for the evaluation of subsequent remedial action.

Certain administrative requirements are associated with implementation of Alternative 7. Coordination between the steering committee and regulatory agencies including EPA and MDNR will be required for review and approval of:

- technical plans and specifications;
- scope changes and/or deviations from the specifications;
- selected contractor(s) and disposal facilities.

Additional coordination with the Army Corps of Engineers may be necessary for work in a flood plain or floodway. Long term administrative coordination would be required for reviewing site inspection and monitoring reports. None of the administrative requirements identified above present substantial or insurmountable difficulties.

4.6.6 Overall Protection

Short term risks associated with excavation of contaminated soils can be addressed by implementing relatively straight forward controls such as water application for dust control, sediment barriers for erosion, and utilizing protective equipment for control of exposures to on-site workers. In the long term, implementation of this Alternative should benefit groundwater conditions underlying the site by eliminating a probable source of continued contaminant influx.

There is a potential for adverse environmental impact to occur if the liner and/or leachate collection systems of the selected land disposal facility fail.

4.6.7 Compliance With ARARs

Probable ARARs for Alternative 7 are summarized in Table 4-1. Draft guidance issued by the MDNR regarding the establishment of soil clean-up limits were considered under this Alternative. This Alternative would be a reasonable and effective response to the current situation wherein surface soils have been impacted by past operating practices.

This Alternative involves the off-site land disposal of excavated wastes. The land disposal restrictions contained in 40 CFR 268 were identified as potential ARARs for Alternative 7. Due to the fact that it is currently uncertain whether the wastes to be excavated under this Alternative contain wastes subject to the land disposal restrictions, definitive conclusions regarding compliance with 40 CFR 268 cannot be drawn. However, in the event the land disposal restrictions are determined to be applicable, this Alternative would likely meet applicable treatment standards.

Identified action specific ARARs can be met with this Alternative. Certain permits and approvals will be necessary of the off-site elements of this Alternative.

4.6.8 Cost

The estimated costs for Alternative 7 are summarized in Table 4-11. Major capital cost labor and equipment costs for excavation, staging and loading, transportation costs, and disposal fees, and backfill material and placement costs. As discussed under Alternative 4, contacts with the six land disposal facilities considered in this evaluation formed the basis for the transportation and disposal costs. Stabilization costs were estimated through discussion with two vendors (VFL Technology Corp. and Enreco, Inc.). Additionally, economic information generated during EPA's Site demonstration was considered (unit cost of $97-207/ton of soil). Although only those soils determined to be contaminated with F006 wastes would be treated prior to disposal, there is currently no means of estimating the quantity of those soils. Therefore, the cost estimate reflects treatment of all soils excavated as a maximum cost scenario for this Alternative.

Total capital costs are estimated to be about $7,796,950, with annual operation and maintenance cost of $5,900 (See Table 4-15). The thirty year present worth associated with the annual operation and maintenance costs is $55,560. The total estimated present worth is about $7,853,000.

4.7 Alternative 8 - Selected Vadose Zone Excavation/Stabilization/Disposal

4.7.1 Description

Alternative 8 consists of a combination of the partial excavation, stabilization and off-site land disposal technologies. Under this Alternative, some of the soils located within the site boundaries and situated above groundwater table will be excavated and shipped to off-site disposal. As discussed under Alternative 5, the quantity to be excavated was estimated at 7,160 cubic yards. This was based on excavation to the clean-up levels specified in Column 6 of Table 2-1.

TABLE 4-11

COST ESTIMATE - ALTERNATIVE 7
VADOSE ZONE EXCAVATION/STABILIZATION/DISPOSAL

Item No.	Description	Total Cost($)	
1.	Excavate and load contaminated soil		
	Labor	334,800	
	Equipment	286,440	
	Materials	379,750	
	Subcontractor/Expenses	111,440	
	Subtotal		1,112,430
2.	Transportation		742,000
3.	Disposal		3,528,000
4.	Backfill and Restoration		
	Labor	36,000	
	Equipment	13,050	
	Materials	96,755	
	Subcontractor/Expenses	6,480	
	Subtotal		152,305
5.	Support Services & Restoration		
	Labor	145,040	
	Equipment	39,300	
	Materials	13,550	
	Subcontractor/Expenses	68,620	
	Subtotal		266,510
	Estimated Total Items		5,801,245
	Engineering (12%)		696,175
	Total Estimate		6,497,420
	Contingency (20%)		1,299,530
	Project Estimate with Contingency =		7,796,950
			(7,800,000)

(CL5189B/11)

TABLE 4-12

ANNUAL COST ESTIMATE - ALTERNATIVE 7
VADOSE ZONE EXCAVATION/STABILIZATION/DISPOSAL

Item No.	Description	Unit	Quantity	Annual Costs Unit Cost ($)	Total Cost ($)
1.	Site Inspection	Event	4	$1,050	$ 4,200
	Total Annual Cost				$ 4,200
	Engineering (12%)				504
	Subtotal				$ 4,704
	Contingency (25%)				$ 1,176
	TOTAL ANNUAL COST				$ 5,880
	PRESENT WORTH OF ANNUAL COSTS =				$55,650

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Due to the relatively shallow depth to groundwater, soil removal would be accomplished using conventional construction equipment such as backhoes and/or front end loaders. The excavated soils would be treated, as necessary to meet land ban standards for soils contaminated with F006 wastes by stabilization/fixation prior to off-site disposal. Only those soils that are determined to be contaminated with F006 wastes and that would not pass the applicable TCLP test (40 CFR 268.41), would be treated prior to disposal. All other soils excavated to the clean-up levels shown in Column 6, Table 2-1, would be disposed at an approved RCRA facility. It is assumed that the stabilization/fixation agents chosen would be portland cement and a proprietary additive (chloranan). For the purposes of this FS, it has been assumed that pre-disposal treatment of the excavated soils will be performed on-site using a pug mill or similar mixing equipment. The wastes would then be transferred into tractor trailers for shipping to the disposal site. At the disposal site the soils would be placed into an approved land disposal cell.

The excavated portions of the site would be backfilled using clean, imported bank run gravel (or other suitable material). Backfilling would be accomplished in controlled lifts with mechanical compaction. The site would be graded to promote drainage and revegetation.

Operation and maintenance activities under this alternative would consist of quarterly site inspections by a professional engineer to examine the site for differential settling, erosion, and security system integrity.

4.7.2 Reduction of MTV

This alternative provides for the removal of soils containing contaminants where clean-up levels from the Vadose Zone area and, therefore, with regards to the site itself, there is a significant reduction in MTV concerns from these contaminants. The stabilization/fixation processes will reduce the mobility of the inorganic contaminants present in the excavated soils (see Section 4.3.2). A substantial volume increase in the order of 100% will result with the use of the chloranan additive. Although the toxicity and volume of the removed soils are not reduced, the soils will be disposed of in an acceptable, controlled facility such that they no longer pose an unacceptable risk.

4.7.3 Short Term Effectiveness

The level of protection and afforded to the local community and on-site workers during construction may be compromised by certain elements of work under this Alternative. During waste excavation, treatment and loading activities, dusts could be generated and transported off-site. As shown in Table 3-1, dust control measures such as water application, have been incorporated into Alternative 8 as a means of mitigating short-term impacts associated with dust emissions. There is also a potential for direct contact and/or inhalation exposures to occur to site workers during waste handling activities. Site workers can be effectively protected against these risks by utilizing conventional respiratory and dermal protective equipment and clothing.

Environmental impacts associated with this alternative include potential transport of excavated materials into the adjacent river via surface water runoff. This could be effectively mitigated by the use of sediment control barriers between the disturbed areas and the river. Containment features could be incorporated into the design of the staging area to prevent transport of staged wastes.

Response objectives could be met shortly after initiation of the work under this Alternative. It is likely that Alternative 8 would satisfy the following objectives established for Operable Unit One:

- Preventing direct contact with contaminated soils;
- Preventing inhalation and ingestion of contaminated soils;

Concerns regarding contaminants present in soils below the groundwater table that would not be removed under this Operable Unit will be addressed as part of a subsequent Operable Unit.

A design and construction period of less than 10 months is considered realistic for this Alternative.

4.7.4 Long Term Effectiveness and Permanence

In the long term, this Alternative would not attain target risk levels for all contaminated soils as set forth in Section 2.2. Those soils situated below the groundwater table which contain contaminants above the clean-up levels would not be addressed. The controls established under this Alternative should be both adequate and reliable. Long-term inspections and periodic repairs to the security and monitoring systems would be necessary to ensure the adequacy of this Alternative.

Residuals from stabilization of the excavated soils pose little uncertainty regarding containment in the selected land disposal facility. Potential uncertainties include failures in the liner and leachate collection systems at the selected land disposal facility, and the resultant release of hazardous substances to the environment.

4.7.5 Implementability

The individual technologies utilized in this Alternative are conventional, well demonstrated, and commercially available. Excavation can be accomplished using common earth moving equipment and transportation can be accomplished using conventional over-the-road tractor trailers. Stabilization/fixation can be accomplished on-site using a pug mill or similar mixing equipment. Sufficient space is available for the on-site treatment equipment. A treatability study would be necessary to identify the most useful stabilization/fixation agents and the appropriate reagent doages (see Section 4.3.5). Off-site land disposal of the excavated soils can be achieved at a number of permitted facilities (provided they are in compliance with EPA's off-site disposal policy). As discussed under Alternative 4, six land disposal facilities located within reasonable distances were considered in this evaluation. No capacity or acceptability problems were identified.

The space constraints discussed in Section 4.3.5 also apply to implementation of this Alternative, but should be manageable due to the limited quantities involved. The capability to stage and relocate the solidified mass may be necessary due to the large volume increases expected. Under this Alternative the 9,400 cubic yards of excavated soils would yield about 19,000 cubic yards of solidified mass. Since only part of the site will be excavated to depths greater than 2 feet, site work can be sequenced so as to utilize those areas where excavation is limited to the two foot depth.

It is currently anticipated that future remedial actions may be necessary to address groundwater problems in the area. The implementation of this Alternative as a first operable unit would not adversely impact subsequent response action(s).

Further monitoring of the site soils and potential exposure/migration pathways would not be necessary after completion of this Alternative. Post-implementation groundwater monitoring may be necessary for the evaluation of subsequent remedial action.

Certain administrative requirements are associated with implementation of Alternative 8. Coordination between the steering committee and regulatory agencies including EPA and MDNR will be required for review and approval of:

- technical plans and specifications;
- scope changes and/or deviations from the specifications;
- selected contractor(s) and disposal facilities.

Additional coordination with the Army Corps of Engineers may be necessary for work in a flood plain or floodway. Long term administrative coordination would be required for reviewing site inspection and monitoring reports. None of the administrative requirements identified above present substantial or insurmountable difficulties.

4.7.6 Overall Protection

Short term risks associated with excavation of contaminated soils can be addressed by implementing relatively straight forward controls such as water application for dust control, sediment barriers for erosion, and utilizing protective equipment for control of exposures to on-site workers. In the long term, implementation of this Alternative should benefit groundwater conditions underlying the site by eliminating a probable source of continued contaminant influx.

There is a potential for adverse environmental impact to occur if the liner and/or leachate collection systems of the selected land disposal facility fail.

4.7.7 Compliance With ARARs

Probable ARARs for Alternative 8 are summarized in Table 4-1. Draft guidance issued by the MDNR regarding the establishment of soil clean-up were considered under this Alternative. This Alternative would be a reasonable and effective response to the current situation wherein surface soils have been impacted by past operating practices.

This Alternative involves the off-site land disposal of excavated wastes. The land disposal restrictions contained in 40 CFR 268 were identified as potential ARARs for Alternative 8. Due to the fact that it is currently uncertain whether the wastes to be excavated under this Alternative contain wastes subject to the land disposal restrictions, definitive conclusions regarding compliance with 40 CFR 268 cannot be drawn. However, in the event the land disposal restrictions are determined to be applicable, this Alternative would likely meet applicable treatment standards.

Identified action specific ARARs can be met with this Alternative. Certain permits and approvals will be necessary of the off-site elements of this Alternative.

4.7.8 Cost

The estimated costs for Alternative 8 are summarized in Table 4-13. Major capital cost labor and equipment costs for excavation, staging and loading, transportation costs, and disposal fees, and backfill material and placement costs. As discussed under Alternative 4, contacts with the six land disposal facilities considered in this evaluation formed the basis for the transportation and disposal costs. Total capital costs are estimated to be $3,332,980, with annual operation and maintenance cost of $5,900 (See Table 4-14). The thirty year present worth associated with the annual operation and maintenance costs is $55,560. The total estimated present worth is about $3,389,000. Stabilization costs were estimated through discussion with two vendors (VFL Technology Corp. and Enreco, Inc.). Additionally, economic information obtained during EPA's SITE demonstration was considered ($97-207/ton of soil). Although only those soils determined to be contaminated with F006 wastes would be treated prior to disposal, there is currently no means of estimating the quantity of those soils. Therefore, the cost estimate for Alternative 8 reflects treatment of all excavated soils as a maximum cost scenario.

TABLE 4-13

COST ESTIMATE - ALTERNATIVE 8
SELECTED VADOSE ZONE EXCAVATION/STABILIZATION/DISPOSAL

Item No.	Description	Total Cost($)	
1.	Excavate and load contaminated soil		
	Labor	$110,400	
	Equipment	123,200	
	Materials	156,140	
	Subcontractor/Expenses	46,900	
	Subtotal		$ 436,640
2.	Transportation		$ 316,230
3.	Disposal		$ 1,503,600
4.	Backfill and Restoration		
	Labor	16,000	
	Equipment	5,800	
	Materials	55,320	
	Subcontractor/Expenses	3,105	
	Subtotal		$ 80,225
5.	Support Services & Restoration		
	Labor	62,820	
	Equipment	17,000	
	Materials	10,150	
	Subcontractors/Expenses	53,230	
	Subtotal		$ 143,200
	Estimated Total Items		$ 2,479,895
	Engineering (12%)		$ 297,585
	Total Estimate		$ 2,777,480
	Contingency (20%)		$ 555,500
	Project Estimate with Contingency =		$ 3,332,980

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TABLE 4-14

ANNUAL COST ESTIMATE - ALTERNATIVE 8
SELECTED VADOSE ZONE EXCAVATION/STABILIZATION/DISPOSAL

Item No.	Item Description	Unit	Quantity	Annual Costs Unit Cost ($)	Annual Costs Total Cost ($)
1.	Site Inspection	Event	4	$1,050	$ 4,200
	Total Annual Cost				$ 4,200
	Engineering (12%)				504
	Subtotal				$ 4,704
	Contingency (25%)				$ 1,176
	TOTAL ANNUAL COST				$ 5,880
	PRESENT WORTH OF ANNUAL COSTS =				$55,650

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5.0 COMPARISON AND SUMMARY OF ALTERNATIVES

A total of thirteen remedial Action Alternatives were developed and evaluated for Operable Unit One at the Auto-Ion Site. These alternatives were subjected to a preliminary screening and a detailed analysis. A No Action alternative was included to provide an assessment of the consequences of postponing or not undertaking action at this time. In section 4, the six alternatives surviving the preliminary screening, were subjected to a detailed analysis according to seven criteria. Each alternative was evaluated without consideration of the other alternatives. In this section, the alternatives will be compared to each other using each of the evaluation criteria. A summary of the comparison of the non-cost elements is provided in Table 5-1.

5.1 Reduction In MTV

No reductions in mobility, toxicity or volume of hażardous substances would be achieved under the No Action Alternative. Reduced mobility would be achievable under Alternatives 3, 4, 5, 7 and 8. Under Alternatives 4 and 5, the reduced mobility is attributed solely to the physical barriers of the selected land disposal facility. Under Alternative 3, the reduction in mobility is attributable to the physical and chemical bonding between the waste constituents and the stabilization/fixation agents, as well as the physical barrier of the cap. Under Alternatives 7 and 8, the reduced mobility is attributable to:

- o the physical and chemical bonds formed between the waste constituents and the stabilization/fixation reagents;

- o the physical barriers of the selected land disposal facility.

TABLE 5-1
SUMMARY OF ALTERNATIVES
EVALUATION

EVALUATION CRITERIA	ALTERNATIVE 1 No Action	ALTERNATIVE 3 Stabilization/Capping	ALTERNATIVE 4 Excavation/Disposal	ALTERNATIVE 5 Selective Excavation/Disposal	ALTERNATIVE 7 Excavation/Stabilization & Disposal	ALTERNATIVE 8 Selective Excavation/ Stabilization/Disposal
Reduction in MTV	*No reduction in mobility. *No reduction in toxicity. *No reduction in volume	*Mobility of organics reduced. *Mobility of inorganics(except arsenic) greatly reduced. *No reduction in toxicity. *Increase in volume(>100%) due to addition of stabilization agents.	*Mobility of organics and in-organics reduced by physical barriers of selected disposal facility. *No reduction in toxicity. *No reduction in volume.	*Mobility of organics and in-organics reduced by physical barriers of selected disposal facility. *No reduction in toxicity. *No reduction in volume.	*Mobility of organics and in-organics reduced by stabil-ization. *No reduction in toxicity. *Increase in volume(>100%) due to addition of stabilization agents.	*Mobility of organics and in organics reduced by stabil ization. *No reduction in toxicity *Increase in volume(>100%) due to addition of stabilization agents.
Short-Term Effectiveness	*No short term risks during implementation *Response objectives would not be met	*Potential but controllable risks due to exposing and disturbing surface soils. *Principal response objective of source removal would not be met, but direct contact & inhalation/injestion would be eliminated.	*Potential but controllable risks due to exposing and disturbing surface soils. *Response objectives can be met.	*Potential but controllable risks due to exposing and disturbing surface soils. *Principal response objective of source removal would be met to the extent that inorg-anics are removed to back-ground levels and organic levels would be reduced. Direct contact & inhalation/ ingestion would be eliminated.	*Potential but controllable risks due to exposing and disturbing surface soils. *Response objectives can be met.	*Potential but controllable risks due to exposing and disturbing surface soils *Principal response objective of source removal would be met to the extent that inorg-anics are removed to back-ground levels and organic levels would be reduced Direct contact & inhalation/ ingestion would be eliminated
Long-Term Effectiveness	*Target risk levels would not be attained for any contaminated soils *Long term inspections nec-essary *Conditions at the site could worsen	*Target clean-up levels for contaminated surface soils would be attained. *Soils below the groundwater table and posing a potential risk >1.0E-06 would not be ad-dressed.	*Target clean-up levels for contaminated surface soils would be attained. *Soils below the groundwater table and posing a potential risk >1.0E-06 would not be ad-dressed.	*Target clean-up levels for contaminated surface soils would be attained. *Soils below the groundwater table and above clean-up levels would not be addressed.	*Target clean-up levels for contaminated surface soils would be attained. *Soils below the groundwater table and posing a potential risk >1.0E-06 would not be ad-dressed.	*Target clean-up levels for contaminated surface soils would be attained *Soils below the groundwater table and above clean-up levels would not be addressed

TABLE 5-1
SUMMARY OF ALTERNATIVES
EVALUATION

EVALUATION CRITERIA	ALTERNATIVE 1 No Action	ALTERNATIVE 3 Stabilization/Capping	ALTERNATIVE 4 Excavation/Disposal	ALTERNATIVE 5 Selective Excavation/Disposal	ALTERNATIVE 7 Excavation/Stabilization & Disposal	ALTERNATIVE 8 Selective Excavation/ Stabilization/Disposal
		*Long term inspections necessary. *Potential uncertainties include failure in capping system. *Further vertical migration prevented by cap. *Potential damage to cap during river flooding could be problematic.	*Groundwater conditions underlying the site should be benefited due to removal of source of contaminants.	*Groundwater conditions underlying the site should be benefited in that inorganics are are removed to background levels and sources of organic contaminants are reduced.	*Groundwater conditions underlying the site should be benefited due to removal of source of contaminants.	*Groundwater conditions under lying the site should be benefited in that inorganics are are removed to background levels and sources of organic contaminants are reduced
Implementability	*Readily implementable *Nothing is required other than periodic monitoring & site inspection *No significant administrative requirements	*Not readily implementable due to >100% volume increase and resulting grade changes/steep slopes on cap. *Construction of capping system can be accomplished using common earth moving equipment. *No significant administrative requirements.	*Readily implementable. *Excavation can be accomplished using common earth moving equipment. *Transportation can be accomplished using conventional tractor trailers. *Permits required for off-site disposal. *Scheduling delays may occur. *No significant administrative requirements	*Readily implementable. *Excavation can be accomplished using common earth moving equipment. *Transportation can be accomplished using conventional tractor trailers. *Permits required for off-site disposal. *Scheduling delays may occur. *No significant administrative requirements	*Readily implementable but very difficult space constraints. *Excavation can be accomplished using common earth moving equipment. *Transportation can be accomplished using conventional tractor trailers. *Permits required for off-site disposal. *Scheduling delays may occur. *No significant administrative requirements.	*Readily implementable *Excavation can be accomplished using common earth moving equipment. *Transportation can be accomplished using conventional tractor trailers *Permits required for off site disposal. *Scheduling delays may occur *No significant administrative requirements

TABLE 5-1
SUMMARY OF ALTERNATIVES
EVALUATION

EVALUATION CRITERIA	ALTERNATIVE 1 No Action	ALTERNATIVE 3 Stabilization/Capping	ALTERNATIVE 4 Excavation/Disposal	ALTERNATIVE 5 Selective Excavation/Disposal	ALTERNATIVE 7 Excavation/Stabilization & Disposal	ALTERNATIVE 8 Selective Excavation/ Stabilization/Disposal
Overall Protection	*No protection to the environment. *No protection to public health.	*Provides increased degree of protection to the environment through construction of physical barrier and reduced contaminant mobility. *Provides increased degree of protection to human health by blocking pathways for direct contact and ingestion.	*Provides increased degree of protection to human health by removal of source. *Provides increased degree of protection to the environment through source removal. *Potential for adverse environmental impacts to occur if liner and/or leachate collection systems of disposal facility fail.	*Provides increased degree of protection to human health by removal of source. *Provides increased degree of protection to the environment through source removal. *Potential for adverse environmental impacts to occur if liner and/or leachate collection systems of disposal facility fail.	*Short-term risks associated with soil excavation can be addressed by dust controls & use of protective equipment *Long-term risks posed to groundwater greatly reduced. *Potential for adverse environmental impacts to occur if liner and/or leachate collection systems of disposal facility fail.	*Provides increased degree of protection to human health by removal of source *Provides increased degree of protection to the environment through source removal. *Potential for adverse environmental impacts to occur if liner and/or leachate collection systems of disposal facility fail
Compliance with ARARs	*Does not comply with probable action- or substance-specific ARARs *Requirements of MMD/MDNR Draft Guidance will not be satisfied regarding soil clean-up limits.	*Does not comply with probable action- or substance-specific ARARs. *Requirements of MMD/MDNR Draft Guidance will not be satisfied regarding soil clean-up limits. *Does not comply with probable location-specific ARARs regarding floodplains.	*In compliance with probable ARARs. *Compliance with land disposal restrictions, if determined to be applicable, would not be achieved.	*In compliance with most probable ARARs. *Compliance is achieved with the soil clean-up ARARs to the extent that inorganics would be removed to background levels. Organic contaminants would be reduced but may not achieve ARARs. *Compliance with land disposal restrictions, if determined to be applicable, would not be achieved.	*In compliance with probable ARARs. *Compliance with land disposal restrictions, if determined to be applicable, would likely be achieved	*In compliance with most probable ARARs *Compliance is achieved with the soil clean-up ARARs to the extent that inorganics would be removed to background levels. Organic contaminants would be reduced but may not achieve ARARs *Compliance with land disposal restrictions, if determined t be applicable, would likely b achieved

No reduction in the toxicity of the wastes would be realized under Alternatives 4, 5, 7 or 8. No reduction in volume would be realized under any of the Alternatives considered. A volume increase on the order of 100% would occur under Alternatives 3, 7 and 8 due to the addition of stabilization/fixation reagents.

5.2 Short Term Effectiveness

Table 5-1 illustrates several differences among the Alternatives in terms of the degree of short term effectiveness provided. The No Action Alternative does not present any short-term risks during implementation. Each of the Alternatives involving active site work pose potential risks due to exposing and disturbing contaminated soils. These risks are all readily controllable or manageable by use of:

- o water application for dust control;
- o sediment barriers and containment structures for run-off control;
- o personnel protective equipment for controlling exposures of site workers.

None of the Alternatives are believed to present appreciable risks to individuals away from the immediate construction areas.

Response objectives can be met under Alternatives 3, 4, 7 and 8. None of the response objectives would be achieved under the No Action Alternative. Alternatives 3, 4, 7 and 8 provide for elimination of direct contact and inhalation/ingestion via construction of physical barriers or source removal. Additionally, the secondary objective of source removal would be achieved for Alternatives 4 and 7, partially achieved for Alternatives 5 and 8, but would not be achieved for Alternative 3.

No significant differences in the time required for implementation are evident among Alternatives 1, 3, 4, 5, 7 and 8.

5.3 Long Term Effectiveness

In terms of long-term effectiveness and permanence, there are several evident and significant differences among the alternatives evaluated. The No-Action Alternative offers no long-term environmental improvement, or reduction in public health risks. Alternatives 3, 4 and 5 do attain the target risk levels set forth in section 2.2. Alternatives 4 and 7 attain an additional objective of removing the source of potential groundwater contamination, while Alternatives 3, 5 and 8 partially meet this objective.

Long term uncertainties regarding potential damage to the capping system during flooding of the Kalamazoo River were identified for Alternative 3. Under Alternative 3, severe damage to the cap is considered to be a major deficiency as stabilized wastes would be re-exposed to the environment. Furthermore, long term durability of the waste stabilized to repeated freeze/thaw and wet/dry weathering cycles is unknown.

Alternatives 4, 5, 7 and 8 present a degree of uncertainty in regard to the long-term effectiveness of land disposal. Under these alternatives, failure of the liner and/or leachate collection systems at the selected land disposal facilities could result in a release from the disposal facility of hazardous substances to the environment. This risk is considered minimal, as the ultimate disposal facility will be operated in accordance with RCRA regulations.

5.4 Implementability

Several similarities regarding the implementability of the various alternatives became apparent during the detailed analysis. It is quite possible that future remedial action to address groundwater problems may be necessary. None of the alternatives evaluated were found to be inconsistent with, or to pose significant constraints to, future groundwater remediation at the Site.

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The No-Action alternative is considered readily implementable since the required security and monitoring systems are currently in place. Alternatives 3, 4, 5, 7 and 8 are also implementable using commonly available techniques, materials and equipment.

Another similarity in the implementability of the various alternatives is the lack of substantial or insurmountable administrative requirements. Although certain review, approval and agency coordination measures would be necessary, these were all considered appropriate and manageable.

There are, however, a number of differences among the Alternatives in terms of their respective ease of implementation. Insurmountable space constraints are likely to be major problems under Alternatives 3 and 7. The need for large staging areas for the stabilized waste, coupled with the need to excavate all site soils above groundwater and the need to locate the required treatment equipment on-site cannot be satisfied by the limited space available at the Auto-Ion Site.

Implementation of Alternative 3 poses a problem not associated with any of the other Alternatives. Under this Alternative, the 19,000 cubic yards of stabilized waste would result in final grades at least 10 feet above existing grades. Over a site of limited dimensions, this elevation differential would require steep slopes, which may prove too steep for cap construction and maintenance.

One difference in the implementability of some of the alternatives involves the ability to obtain the necessary treatment and/or disposal facility approvals. Alternatives 4, 5, 7 and 8 present some likelihood that scheduling delays may result during attempts to obtain disposal approvals. These difficulties are not associated with Alternatives 1 and 3. Several land disposal facilities are located within reasonable distances (<250 miles). Contacts with the facilities revealed there are likely to be no capacity or acceptance problems.

Alternatives 3, 7 and 8 would require a predesign treatability study to determine an appropriate stabilization mix and to evaluate the actual reduction in mobility that can be achieved. No treatability studies are necessary under Alternatives 1, 4 and 5.

5.5 Overall Protection

Differences between the alternatives in terms of the degree of overall protection to human health and the environment provided, became evident as a result of the detailed evaluation. A very limited degree of protection is provided under Alternative 1, No Action. On the other hand, Alternatives 4 and 7 appear to provide the greatest degree of protection. This is due to the complete removal from the site of all Vadose Zone soils. Alternatives 5 and 8 provide a similar degree of protection in that all contaminated surface soils that present an inhalation/ingestion risk and remaining Vadose Zone soils contaminated with inorganics above background levels are removed from the site and are disposed of at a permitted site. Alternative 3 provides a lesser degree of protection.

Alternatives 3, 4, 5, 7 and 8 pose certain short-term implementation risks, however these can be effectively mitigated through the use of straight-forward controls.

5.6 Compliance With ARARs

Alternative 1 does not comply with probable action-specific or substance-specific ARARs. Additionally, the No-Action Alternative does not satisfy the requirements of the WMD/MDNR Draft Guidance regarding soil clean-up limits. Alternatives 5 and 8 comply with most of the probable ARARs identified. Alternative 3 would not comply with the location-specific ARARs regarding floodplains, nor with the As with Alternative 1, the requirements of the WMD/MDNR Draft Guidance would not be fully satisfied under Alternative 3.

Alternatives 4 and 7 were found to be in compliance with the respective, probable ARARs.

In the event the land disposal restrictions are determined to be applicable to wastes under this Operable Unit, Alternatives 3, 7 and 8 would probably achieve the appropriate treatment standards for metals. However, Alternatives 4 and 5 would probably not achieved those standards due to the fact that treatment is not a component of those Alternatives.

5.7 Cost

The estimated costs for the four Alternatives are summarized in Table 5-2 and illustrated in Figure 5-1. No Action presents the least financial commitment whereas Alternative 7 presents the greatest.

TABLE 5-2

SUMMARY OF ALTERNATIVE COST ESTIMATES

Alternative	Estimated Capital Costs	Estimated Annual Costs	Present Worth of Annual Costs	Total Present Worth*
1 - No Action	-0-	$57,750	$544,500	$545,000
3 - Stabilization/ Capping	$ 1,857,600	$70,980	$669,350	$2,530,000
4 - Vadose Zone Excavation/ Disposal	$ 3,755,250	$5,900	$55,650	$3,810,000
5 - Selected Vadose Zone Excavation/ Disposal	$ 1,672,160	$5,900	$55,650	$1,730,000
7 - Vadose Zone Excavation/ Stabilization/ Disposal	$7,796,950	$5,900	$55,650	$7,850,000
8 - Selected Vadose Zone Excavation/ Stabilization/ Disposal	$3,332,980	$5,900	$55,650	$3,390,000

NOTES:

*Rounded to three significant figures.

FIGURE 5-1

COMPARISON OF ALTERNATIVE COSTS